SCIENTIFIC AMERICAN SUPPLEMENT. No. 1323

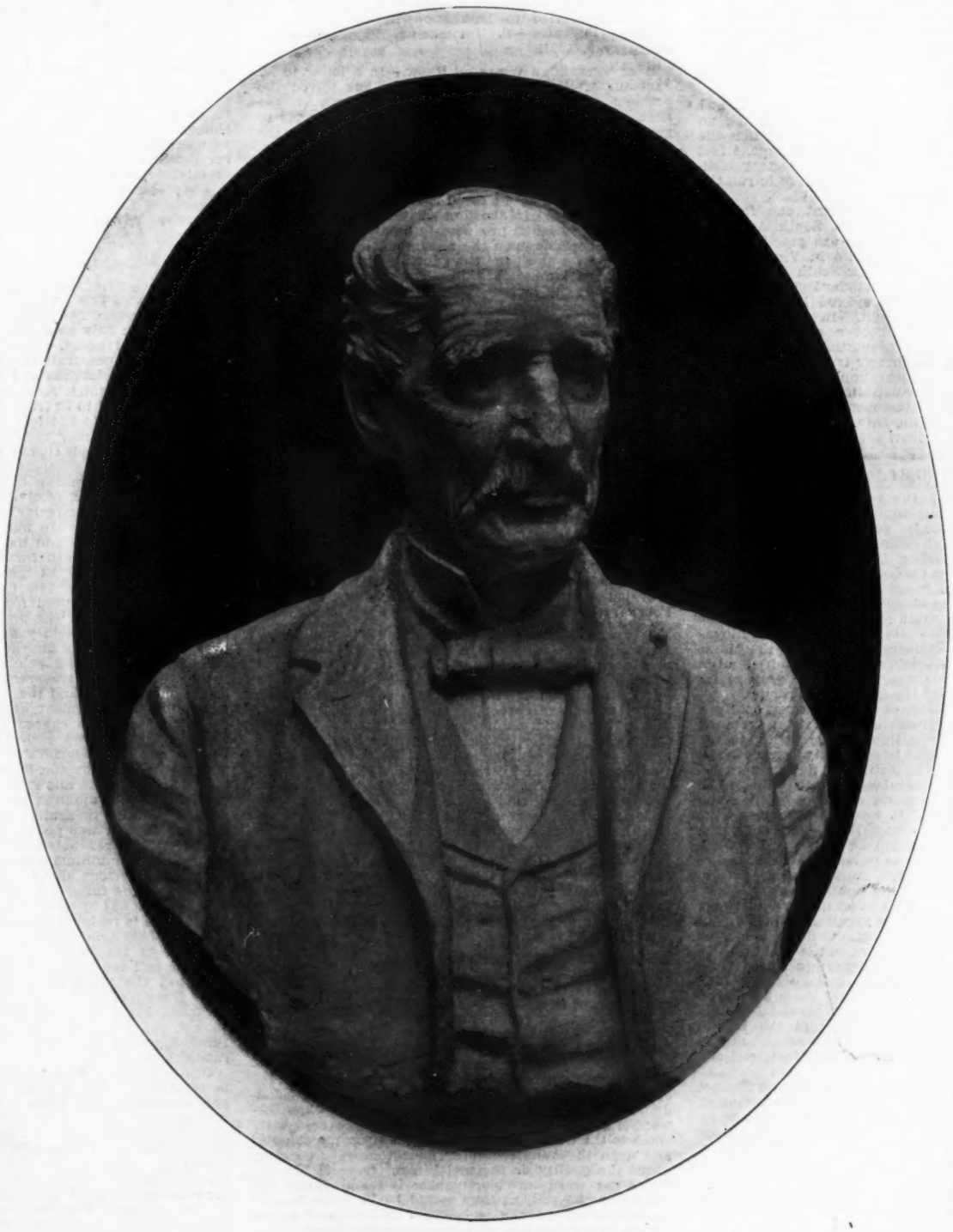
Copyright, 1901, by Munn & Co.

Scientific American, established 1845.
Scientific American Supplement, Vol. LI. No. 1323. NEW YORK, MAY 11, 1901. Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

CHARLES H. HASWELL, M.E.

THE Right Honorable the Earl of Hopetoun, the President of the Institution of Naval Architects of Great Britain, made the following reference to the subject of our biographical sketch, at the last Annual Meeting of the Institution, saying: "Mr. Haswell is, I fancy, the oldest practising engineer in the world. He was Chief Engineer of the United States Navy at the time Her [late] Majesty came to the throne, and that was not yesterday. I also remind you that he was present at the International Congress held about a year ago and was about the youngest of them—he was here, there and everywhere." These remarks would justify interest in Mr. Haswell, even though his remarkable personality and achievements were not considered.

He was born in New York city on May 22, 1809, and is, consequently, ninety-two years old. He received a classical education, and also practical mechanical training at the West Point Foundry, and at the Allaire Works, New York city. He entered the navy in 1836 as Chief Engineer and was commissioned Engineer-in-Chief in 1843. When Mr. Haswell entered the navy there was but one steamship in it, and he had more or less to do with the designing of steamers for the navy up to 1852, when he became consulting engineer in the city of New York. During this period twenty-seven vessels were constructed. He was an early advocate of the screw-propeller for war vessels, and in this he was opposed by many of the best engineers. In 1848 two similar ships were laid down, one, the "Saranac," to have paddles, and the other, the "San Jacinto," to have a screw-propeller. The engines of the paddle steamer were designed by Mr. Copland. Mr. Haswell designed those of the latter and introduced many remarkable improvements; and while the "Saranac," which was not so much of an experimental ship, proved the better of the two at first, in the end the "San Jacinto" was improved so that she was superior. Mr. Haswell began the creation of an Engineer Corps in the navy after the Navy Department was reorganized in 1842. Largely through his interest and advice Congress established the Engineer Corps in the navy, which existed through three wars. After he retired from the navy in 1851, he built several merchant steamers and designed and built various important engineering structures. He now had not only a national, but an international reputation, and in 1853 Emperor Nicholas presented him with a diamond ring for professional services. In 1847 Mr. Haswell applied zinc to a steam boiler and also in the hold of a steamship to arrest the corrosive action of salt water. In 1839 he introduced a system of making boiler-plates rolled and trimmed to fit every location in a boiler, which is now the universal practice. In connection with his professional work Mr. Haswell designed and erected many large plants and buildings and supervised the testing of water works, etc. He is now consulting engineer for the New York Board of Public Works and is also superintending constructions and improvements on Riker's Island. His "Mechanics' Pocketbook," which has passed through more editions than any book of its kind, is an excellent work. In addition to his works bearing on his profession Mr. Haswell has written a delightful book entitled "Reminiscences of an Octogenarian of New York City, 1816-1860." Our engraving is taken from a bust which has recently been placed in the Union Club, of which he has been a member since 1851.



CHARLES HAYNES HASWELL, M.E.

The Kiel shipbuilding yard is building submarine boats for private individuals.

A TRANS-AUSTRALIAN RAILWAY.

AMONG the most important of the many practical projects which will engage the attention of the federal government of Australia in the earliest days of its existence will be that of the Trans-continental Railway.

The scheme, which in some respects, bearing in mind the smallness of the Australian population, is one of the most remarkable in the history of modern railway development, is to bring the extreme west of the commonwealth into communication with the extreme east by means of an iron road upward of a thousand miles in length, skirting the Great Australian Bight along a region as yet practically untrodden by civilized man.

Under the existing railway systems Western Australia is entirely cut off from the sister states of the federation. She has some 350 miles of railway connecting Fremantle and Perth with Albany, a northern system extending as far as Murchison County and a line 390 miles in length connecting Perth with Kalgoorlie, the center of the gold district. There are also subsidiary and private lines, bringing the total mileage up to 1,892. From the easternmost point of the system, however, there is an unbroken tract of country a thousand miles in extent to Port Augusta, at the head of Spencer's Gulf, South Australia.

Though the railway mileage of the Southern State is some 162 miles less than that of Westralia, the network principle which has been adopted has served to open up the country to much better effect than the direct lines of the Western State.

Port Augusta is the starting point of the Great Northern line, which stretches up away through the great Lake Country, and, branching off at Quorn, extends eastward to Broken Hill, and runs southward to Adelaide, and thence to Melbourne by way of Murray Bridge, Serviceton, Ballarat and Geelong, a clear run of a little over five hundred miles.

Victoria has some thirty-two hundred miles of railways, which radiate from the capital in all directions, the main tentacles being connected by innumerable shorter lines all over the State. From Melbourne to Sydney is a run of 576 miles by way of Benalla, Albury Wagga Wagga, Yass, Goulburn and Mittagong.

The New South Wales Railway connects at Albury with that of Victoria, and comprises 2,811 miles, divided into three large systems—the Southern, from Sydney to Albury; the Western, running from Granville to Bourke, a distance of 506 miles, and the North Coast line, which runs through the Liverpool and New England ranges, and, reaching a height of 4,471 feet above

sea level at Ben Lomond, connects with the Queensland system at Jennings, 491 miles from Sydney, while the whole run from Sydney to Brisbane is some 720 miles.

Queensland is unique in the matter of railway service, possessing, as she does, thirteen distinct systems, comprising an aggregate of 2,801 miles of track. Of this total 592 miles in the northern division and 95 miles at Carpentaria are short, detached lines, not in communication with the main line systems.

Thus, the Cooktown Railway runs inland some sixty-seven miles as far as Laura, while the Townsville line takes a southwesterly direction for 368 miles to Winton, but both of these ports are isolated, except so far as sea communication is concerned.

In the five commonwealth states of the Australian continent there are thus some 12,500 miles of railway communication open, but as each colony in the old days studied only the opening up of its individual resources, without paying much heed to the question of intercolonial communications, the federal government has obviously some very large problems to consider in respect of the linking up of both the state and the interstate systems.

The first and largest and most important of these problems is the Transcontinental Railway, to which reference has already been made. Sir John Forrest, Premier of Western Australia and now Federal Postmaster-General, has formulated a plan for this important undertaking which stands every chance of being adopted when the federal government gets to work.

The proposal is to run a line from Kalgoorlie, in the Westralian gold fields, to Port Augusta, the western terminus of the South Australian system, and it is estimated that the 1,000 mile run of the transcontinental line could be built for from £2,000,000 to £2,500,000, the latter being an outside estimate.

Sir John has personally inspected the ground, and he reports it to be a level table land, presenting no serious engineering obstacles. It is proposed that the line should be constructed on the standard gage, 4 feet 8½ inches, since in order to derive the greatest possible benefit from the line it will be necessary to run the trains at a considerable speed.

The gage question is an important one for the future of Australia. In Westralia, South Australia and Queensland the existing lines are practically all on the 3 feet 6 inches gage, while in Victoria they are on a 5 feet 3 inches gage, New South Wales being the only state which uses the standard gage.

That the traffic over the projected line would be very large admits of no doubt. In the matter of the mails alone it would effect a saving of three days, while a very large proportion of passengers would probably prefer the shorter train journey across the continent to the frequent unpleasantness of the passage across the Great Australian Bight. There is also the great question of the opening up of enormous new tracts of country to the enterprise of the agriculturist or the mineral seeker.

REPORTING STEAMSHIPS.

Simultaneously with the report that the Cunard Steamship Company will equip its passenger vessels with wireless telegraphic instruments comes a demand, by a correspondent of The London Times, for a change in the method of reporting Liverpool steamers from the United States when they approach the Irish coast. At the present time it is customary for the liners to run up within signaling distance of Brow Head, a spur o' Mizzen Head, the southwesternmost point of the Emerald Isle. There is situated one of the Lloyds stations, and thence a telegram is sent by the Morse system to Queenstown, eighty or one hundred miles away, giving about four hours' notice to prepare for taking off the mails, says the New York Tribune.

Now, about seven miles to the southeast of Brow Head is Fastnet, a bold pinnacle of rock rising from the sea and surmounted by a lighthouse. Owing to the presence of other rocks and islets in this neighborhood, the steamship officers are instructed not to pass between Fastnet and the mainland, but to keep to the southward of it. Consequently a saving of time and trouble would be effected if Fastnet were made the signal station instead of Brow Head. The agitation of the question will probably lead to the transfer. A Lloyds agent will doubtless be posted at Fastnet before many months, but permission must be secured from the authorities in charge of the lighthouse service.

But inasmuch as there is no telegraph cable between Fastnet and the mainland, it is suggested that Marconi apparatus be installed there. This would be employed primarily to send messages ashore, but it could also be used in exchanging signals with passing ships if the latter were similarly equipped. If the Cunard Line adopts the scheme, it is probable that the other Liverpool steamships will too. Already wireless telegraphy is used in reporting incoming ships in the Bristol Channel, and at the Skerries near Anglesea, and experiments are now in progress between Rathlin Island and the north coast of Ireland.

The proposed wireless telegraphic station at Fastnet would be of no value to the American Line steamers, which run to Southampton, nor the Havre, Antwerp, Bremen and Hamburg ships. These usually approach the European coast at the Lizard or the Scilly Islands, some seventy-five miles further south than Ireland. While no definite announcement has been made to that effect, it seems probable that an installation like that at Fastnet will be set up on the Scilly Islands before many years.

The experiments made by the North German Lloyd Company, a year ago last winter, near the European terminus of their route, were conducted on Borkum Island, at the mouth of the Ems. Messages were received at that point from vessels fifty miles away and altogether out of sight. It would probably be found advantageous to report North German Lloyd ships from both Scilly and Borkum.

Inasmuch as all vessels from Northern Europe, of whatever line, run rather close to Nantucket, that island affords what seems to be the most advantageous site for a wireless telegraph station on this side of the Atlantic for the benefit of incoming shipping. Mr. Marconi announced several weeks ago that one of the objects which he had in view in visiting America at the present time was to promote a project of that kind. Of course, such a station would be of no value until the steamers were equipped with instruments.

CONTEMPORARY ELECTRICAL SCIENCE.*

The Electro-Radiophone.—T. Tommasina describes an interesting new instrument for detecting and studying distant thunderstorms, and gives some graphic details of its use on some special occasions. The apparatus consists essentially of a selfdecohering carbon coherer, placed in circuit with a dry cell and an ordinary telephone receiver. The carbon is in grains, prepared from arc carbons, thoroughly dried by heat, and sealed up hermetically in a glass tube attached to the telephone magnet, so as to lie horizontally when the telephone is put to the ear. With this arrangement, the author discovered that certain definite sounds corresponded to every indication of Lera's electro-radiograph as installed at Catania. The impression produced upon the observer was that of being transported into the neighborhood of the thunderstorm which might yet be hidden below the horizon. To strengthen the effect the author used three copper "antennæ," each 30 meters long, taking due precautions against shock. In this manner it was found possible to observe the development of a violent thunderstorm at a distance for 12 hours before it broke loose at the observing station, which was situated on the Lago Maggiore. A distant rain is indicated by a rattling sound before a cloud is visible. The author believes that his apparatus, simple as it is, will be of important service to navigation in the matter of weather forecasts.—T. Tommasina, Phys. Zeitschr., February 9, 1901.

Bare Telephone Wires on Snow.—In a letter to M. Janssen, A. Ricco announces that he has solved the problem of maintaining communication between the Etna observatory and Nicolosi by the expedient, suggested by Janssen, of laying the bare wire over the frozen snow. The experiment has been perfectly successful.—Ricco and Janssen, Comptes Rendus, February 11, 1901.

Current Intensity of Lightning Flashes.—F. Pockels succeeded in showing some time ago that the remanent magnesium produced in basalt by a magnetic field only depends upon the maximum intensity of the latter, however short the time during which that maximum intensity might prevail. This fact may be used to determine the current intensity of lightning flashes. For this purpose a rod of basalt would be placed near a lightning conductor in such a position that the circular lines of magnetic force produced by a discharge would approximately pass through the length of the rod. The maximum intensity of the discharge current would then be calculated by the formula

$$i = \frac{5L}{2 \tan \frac{L}{2a}} H \text{ (amperes).}$$

H would have to be found in terms of the remanent magnetism of the basalt by previous experiments. Such experiments, when made by the author, gave for $H = 100$, $m_r = 0.1434$, and for $H = 310$, $m_r = 0.5246$. Some basalt rods were thus successfully exposed by Chistoni in the Monte Cimone observatory in the Apennines, and the resulting magnetizations indicated currents of 10,000 to 20,000 amperes. Another rod showed a feeble magnetization, probably due to the prevalent St. Elmo's fire.—F. Pockels, Phys. Zeitschr., February 16, 1901.

Thermo-Electric Ores.—E. van Aubel has subjected Abt's electromotive series of thermo-electric substances to a searching investigation. It will be remembered that Abt constructed the following series: Chalcopyrite, pyrolusite, bismuth, zinc, nickel, copper, cadmium, nickel oxide, arc carbon, iron, pyrohotite, antimony, and pyrite +, and maintained that this series followed the law of thermo-electric force which applies to the metals to a near approximation. Thus the E. M. F. between pyrolusite and carbon would be 315.2 (arbitrary scale), between carbon and pyrite 615.6, and, hence, between pyrolusite and pyrite 930.8, which differs very little from the observed value, 933.2. This approximation is, however, by no means general. Thus, since the pyrite-zinc couple shows an E. M. F. of 600.5, and the pyrite-iron couple an E. M. F. of 635.9, iron should be further removed in the series from pyrite than zinc should. But this is contradicted by the figures derived from pyrolusite coupled with iron or zinc. It appears that a definite series cannot be made to include these minerals.—E. van Aubel, Ann. der Physik, No. 2, 1901.

Propagation of Wireless Waves.—E. Lagrange has endeavored to throw some light on the part played by the earth in the propagation of the electric waves used in space telegraphy. He concludes that the earth behaves as a conductor and not as a dielectric. A coherer was buried in the ground 1 foot deep, at a distance of some 100 yards from a 25 centimeter spark-gap provided with an air-wire 2 meters long. Before the earth was covered over the coherer the latter responded well, and a relay actuated by it exploded a dynamite mine with the greatest ease. But when the wooden box containing the apparatus was covered with earth to the depth of 1 foot all action upon the coherer and upon the mine ceased. The author says nothing about the quality or the moisture of the soil. He believes the waves are partly absorbed and partly reflected by the soil, as they would be by a conductor, and points out that the explosion of underground mines cannot be carried out with the apparatus described.—E. Lagrange, Comptes Rendus, January 28, 1901.

Dielectrics in a Magnetic Field.—The experiments of Faraday and Kerr on the behavior of polarized light in passing through various media, when these are in a magnetic field, or subject to dielectric strain, make it seem possible that the presence of a magnetic field may have some effect on the specific inductive capacity of a dielectric. The following experiments were undertaken by E. C. Roberts in order to discover if possible whether such an effect exists. Although the method of attacking the problem was varied, the whole procedure was based on the fact that if a condenser be charged and insulated, any change in the specific inductive capacity will manifest itself as a change in the P.D. between the coatings. The dielectrics studied (glass, hard rubber, and vulcanite) were used in the form of small condensers. Sheets of tinfoil 5.3² centimeters were fastened on opposite sides of a plate of the dielectric, which was in each case about 20 × 25 centimeters, thus making the leakage path rather long. In the case of glass the whole condenser was covered with shellac to further decrease the leakage. The direction of the electric strain was parallel to the lines of magnetic force in nearly all cases. The magnetic field was one of 1,500 lines per square centimeter across an air-gap of 3.5 centimeters. Three different methods were used, but in none of them was any magnetic effect upon the specific inductive capacity observed. The limit of observation was such that if the effect had been 1-3,500 of the whole it could still have been observed.—E. C. Roberts, Phys. Review, January, 1901.

Testing of Magnets.—I. Klemencic has found that the magnets which show the greatest permanency when exposed to shock do not at all necessarily possess the greatest resisting power to other demagnetizing influences, but rather the contrary. Magnets should be tested with the same patience as standard cells, and their examination should occupy a corresponding interval of time. Experiments extending over a whole year showed that a magnet which in the first 27 days was placed near the end of the series of permanency advanced to the first place in the course of subsequent tests. This was largely due to its dimensions, and it appears that generally those magnets have a better chance in which the ratio of length to cross section is great. The decrease in the moment is particularly great within the first few days after magnetization, after which it becomes much slower. This indicates two causes of diminution, one of them being the "magnetic after effect" and the other the structural changes connected with the hardness of the metal. In magnets which are not exposed to rough usage, as for instance in magnetometers, specimens with small coercive force are more advantageous. Even soft iron, when preserved from shock, maintains its remanent magnetism for an extraordinary length of time.—I. Klemencic, Ann. der Physik, No. 2, 1901.

* Compiled by E. E. Fournier d'Albe in The Electrician.

ELECTRIC FURNACES.*

Modern electric furnaces are for the most part a development of two primitive types, those of Moissan and of Siemens. The former is characterized by the use of the arc only as a source of heat and not as an electrochemical agent. The arc passes between two carbons which penetrate into a chamber hollowed out of a block of quicklime and closed by a cover of the same material, which receives the heat and reflects it upon the material to be treated, this being placed below the arc. Owing to the low heat-conductibility of the line, the interior may even be fused before the heat is felt on the outside, using 1½-inch walls. The Siemens type is quite different; the first apparatus were designed for the melting of metals, and consisted of a refractory crucible, receiving the current at its base, while the second conductor was formed of a vertical electrode above; the arc was formed between the material in the crucible and the upper electrode. Before considering the modern furnaces, several of the first industrial types may be mentioned, which served to fix modern practice. The Cowles furnace which appeared in 1885 was used for the reduction of oxides and other purposes. The first type consists of a horizontal vessel of refractory material closed at one end by a conducting body and at the other by a graphite crucible as the second pole. The material is placed in the vessel and is traversed by the current after the arc is once formed and the material fused. This permitted of the treatment of non-conducting material. In a later type the charge was continuous; a brick chamber has a hollow carbon electrode at the top and bottom, and the material descends through the former and is taken out by the latter. The Heroult furnace is a modification of this type and was first applied for the reduction of alumina by copper. The copper was first introduced in grains, and when melted by the current alumina was poured in and an alloy of aluminium and copper obtained. This type was further modified for aluminium and carbide of calcium and has a vertical electrode above a chamber whose bottom is of carbon; the furnace is placed on wheels. The carbide is taken out by an orifice below, and when finished the furnace is replaced by another.

Recent Industrial Furnaces.—The appearance of carbide led to the study of electric furnaces of great capacity and constant working. Based upon the types described the ideas of inventors divided, and three main types may be considered, these being first the arc furnaces, based upon the Moissan or Siemens types; second, resistance furnaces, based upon the Heroult furnace, and a third type using the principle of incandescence.

Of arc furnaces of the first type, several forms may be mentioned. One of these has one arc and two movable electrodes; the latter are oftenest in an inclined position and mounted in a refractory chamber. The matter is placed around the arc, being introduced from above. The arc is movable, or the material may be raised or lowered. To this type belong the Patin furnace, that of the Deutsche Gold und Silber Anstalt for carbide, the Street furnace for graphite, and others. In the furnaces with one arc and one movable electrode, the latter is generally vertical and the fixed electrode horizontal or inclined, being constructed of an assemblage of carbons called the *sole*. The matter is introduced from above, and the arc passes first between the movable electrode and the sole, then between the electrode and the melted material. On this principle a great many furnaces have been devised. To this class belong the Siemens & Halske systems, the Schuckert, the Société des Carbures Metalliques, and many now used for carbides. Furnaces with multiple arcs are a variation of the former; it was desired to distribute the heat of the arc over greater surface and obtain the necessary temperature over the whole space. Among

* Paper read by M. Keller before the Electrical Congress. Abstract by Paris correspondent of the Scientific American.

these are the Gin & Leleux, Bertolus, Nicolaï, Bovy, etc. The former is used for carbide and for phosphorus; it has four pairs of carbons above a sole movable vertically, thus giving four arcs. The Bertolus type has three movable inclined carbons above a common sole; it is used at the Bellegarde works (France) on the triphase system. In the Nicolaï furnace a fixed metallic crown is covered with carbons and forms one pole, while the other pole has several electrodes disposed in a circle and placed above the crown; upon the latter is placed the material. The Bovy furnace is characterized by the use of several vertical electrodes in the same chamber with a common sole in an inclined position; the electrodes are connected in parallel. Considering arc furnaces in general, it seems that the temperature varies with the current; as the tension is nearly constant for a given case, it follows that in powerful furnaces the temperature is too great in the arc itself; the use of multiple arcs only partially remedies this fault, and from the high temperature at a given point there results a volatilization of the matter, and sometimes decomposition. Besides, the arc has a blowing power and the matter is carried off in fine particles; this causes a loss and also vitiates the air.

The second class of furnaces, which may be called resistance furnaces, are disposed like the former, but work at low tension. The vertical electrode is not placed over the fused material, but plunged into it, and the latter becomes the conductor between the electrode and sole. The electric work thus depends upon the resistance and the square of the current, and the temperature for a given power depends upon the section of the electrodes; a good distribution of heat is thus obtained. The fusion takes place quietly and the gases are not violently blown off, as with the arc. Low tensions of 20 and 25 volts may be used. To this class belong the new Gin & Leleux furnaces, which are used for carbide at a number of works; in this the movable electrode is formed of an assemblage of carbons of different conductibility, measuring up to 32 inches on a side. A third class of furnaces is that in which the electrodes are united by a series of carbon blocks, which become heated to incandescence by the current and constitute a bed of fusion for the material; it has the advantage that the current uses as a conductor only the fused portion of the matter, and is not obliged to traverse it entirely, thus avoiding the losses due to the great resistance of the infused part, as in the other furnaces. To this class belongs the new type of Cowles furnace, having two groups of electrodes, one for the arrival and the other for the return of the current, or two groups of soles which have the same effect.

Electric furnaces may also be divided according to the nature of the current and manner in which it acts. The first electric furnaces used continuous current, and were designated as *electrolytic* or *electrothermic;* in the former, the current served both as a source of heat and as an electro-chemical agent, while in the latter it served only for heating. The use of alternating current has taken a great extension in electric furnaces, and the electrothermic furnaces used for simple fusions or reactions at high temperature employ it for the most part. Both the monophase and polyphase systems are used, but chiefly the former.

The carbon electrodes play an important part, and it is the difficulty of obtaining these of sufficient dimensions and proper form which limits the size and power of the furnaces. The consumption of the electrodes forms in some cases an important item in the cost of production, and the ingenuity of inventors has been exercised on their design and disposition. In the case of vertical, movable electrodes they are formed of an assemblage of high conducting carbons, and have usually a square or rectangular form; in some cases they are protected from the air to prevent burning, and have water or air-cooling arrangements. As to the tensions used in the electric furnace, this depends upon the conductibility of the vapors and the distance between the electrodes; this distance is generally from 1 to 1½ inches for arc furnaces, requiring 50 to 60 volts. In the resistance furnaces the tension may be less; in some cases it does not exceed 25 volts; on the contrary, in the incandescent furnaces last mentioned, it may reach 80 to 100 volts, due to the great resistance between the electrodes. As to the intensity of current used, this has reached, in the Cowles furnaces, as high as 5,000 amperes, corresponding, at 50 to 60 volts, to 350 to 400 horse power. In the Heroult furnace, the current reaches 6,000 amperes; for carbide, furnaces with one arc and two movable electrodes use 1,000 to 2,500 amperes, which, at 50 volts, corresponds to 79 to 170 horse power; this power has been even quadrupled by using four arcs in the same furnace. Furnaces with one arc and one movable electrode are better adapted for heavy currents, and at present 5,000 to 6,000 amperes are commonly reached, corresponding to 400 horse power. The Gin & Leleux furnace, of the resistance type, uses as high as 10,000 amperes at low voltage; the greatest power is obtained from the fusion-fed apparatus, in which, owing to the great quantity of material between the electrodes, as high as 1,300 horse power is utilized in a single furnace.

As to the development of the industry, the total power now used in electric furnaces reaches 230,000, of which carbide represents 185,000; aluminium, 27,000; copper, 11,000, and carborundum, 2,000. Recently the combined production of phosphorus and carbide has been commenced, and some works in Savoy are producing vanadium and ferro-chromium; among other new processes may be mentioned that of artificial corundum by the fusion of bauxite. Great progress has been recently made in the construction of industrial furnaces; thus the efficiency, for the manufacture of carbide, which in 1897 was only 5 pounds per horse power and per 24 hours, has lately been brought in the new Gin & Leleux furnace to 10.2 pounds, which corresponds to a calorific efficiency of 75 per cent.

THE Electrical Lead Reduction Company has resumed manufacture in its new building at Niagara Falls, which replaces that destroyed by fire last March, says The Electrical World and Engineer. The new plant has a capacity about tenfold that of the one burned down, occupying a building 182 feet by 140 feet. The electrical machinery equipment consists of two Westinghouse motors, of 300 horse power each, direct-connected to a Westinghouse direct-current generator of 250 horse power. The process consists in the electrolytic reduction of lead from galena (sulphide of lead) to the form of a sponge. The sponge may then be compressed into the form of storage battery plates, or converted into litharge, red lead, lead peroxide or white lead. One hundred pounds of spongy lead will yield 108 pounds of litharge, 110 pounds of red lead, 116 pounds of lead peroxide, or 125 pounds of white lead. Sulphuric acid is a by-product of the process, 800 pounds of acid being produced for every ton of lead reduced. The present capacity of the factory is 10 tons per day, but this may be extended to 40 tons, and there is sufficient ground space for an eventual capacity of 100 tons. At present the product is confined to litharge for use in rubber manufacture and storage batteries. The galena is procured from Joplin, Mo., and is concentrated, before being shipped, to 80 to 85 per cent metallic lead. About five days are required to reduce the raw material to spongy lead. The sponge is then washed and burned in the furnace to litharge, the product being 99.36 per cent pure, while the highest grade of litharge manufactured by former processes is 98.12. Plant is now being put in for rolling and stamping the sponge into storage battery plates.

THE PROSPECTS FOR ECONOMICAL AUTOMOBILING.

By M. C. KRARUP, New York.

THE slump from which the automobile market in France suffered during the latter half of the year 1900 was followed by a material reduction of the selling prices at the beginning of the present year, and now the public demand for automobiles is being quickly revived in that country. Great Britain and Germany are following suit in a measure modified considerably by the lower range of prices previously prevailing in both these countries. Will something similar take place in America, notwithstanding that our prices from the beginning have been far below the schedules of Europe? And, inquiring further into the future, how long will it be before any person whose economical condition would permit the ownership of horse and vehicle may just as well contemplate the purchase of an automobile?

Commonly these questions take the more definite form: How soon will it be possible to buy a practical, reliable and useful automobile for $500? With this price limit the question refers mainly to pleasure vehicles, from the use of which no pecuniary returns are expected. With reference to business vehicles it may be put a little differently. The American business man does not like a large initial investment in a new venture. He has been accustomed to "turn his capital over" once a year in every enterprise involving risk and personal work. He wants to do the same with business motor vehicles. Spite of all computations of interest and depreciation tending to show that automobiles at their present prices and cost of operation compare favorably with the capitalized cost of horses and their keep, he will continue to consider them dearer so long as their first cost is much higher than that of the horse equipment which suffices for his work. The possible savings in operation, upkeep and time constitute his business chance. It is an uncertain factor, and reimbursement from future savings must be very sure before he will consider it a suitable compensation for a high and certain immediate disbursement. Perhaps the average business man will consider a 25 per cent higher purchase price the limit of "what is about right." If a team of draft horses and a dray cost him $700, he may be willing to pay $900 for a motor dray, but ordinarily not much more.

How soon will he be able to buy it at that figure?

Probably his expectations may be met long before those others can be gratified who hope to buy a smaller power in a pleasure vehicle for about half as much money, for within the moderate dimensions available for vehicles it is not principally size that enhances first cost of machinery and wagon work, but the quality of reliability of the motor as a power producer and the refinement of its operation. Reliability once attained will be imperatively demanded for a small pleasure vehicle as well as for the dray, and refinement in operation is naturally more important in the former.

These principal factors of cost will continue to apply to all sizes of motor vehicles in nearly equal degrees until standard patterns shall have been reached and the manufacture reduced to routine processes, and the tendency must therefore be that of maintaining a certain level below which the prices for an acceptable quality in automobiles cannot descend at any given time, almost irrespective of size and the animal horse-power which the automobile is intended to supplant.

Infractions of this rule at the present stage are more apparent than real. High prices are frequently arbitrary and find little response among the buying public, while low prices, such as asked for motor cycles, represent a deliberately reduced standard of utility, a compromise between economy and vehicle qualities. Purchasers of motor cycles are supposed to "put up with" crudities in construction, design and operation that could not be tolerated in vehicles intended for something more substantial than sportive play. There is nothing derogatory to motor cycles in acknowledging their limitations. They occupy an essentially new field, most nearly comparable to that of the road and track sulky, and it remains to be seen if this field will be cultivated after means shall have been found for removing the shortcomings in automobile vehicles which in the motor cycle are now more or less frankly accepted in consideration of the low price.

The lack of a commonly accepted standard of automobile quality or fitness explains other deviations from that level—about $1,500—at which the highest automobile quality of the day is obtainable in combination with vehicle qualities corresponding to those of a buggy or "spring wagon." Above this level should ordinarily be found the comforts and style of a fine carriage. Below it there is usually a sacrifice of vehicle convenience as well as of motor quality or traveling radius.

One feature in the automobile market seems at first to support the hope of cheap gasoline vehicles. It consists in the manufacture and offering for sale of vehicles complete with pneumatic wheels, steering gear, differential gear and driving pinion, for $200 or less. That is to say, the motor is omitted; also the transmission mechanism. But the supposition is that any good mechanic with an ambition for constructing and owning an automobile can fit the motor of his choice, steam or gasoline, at an expense of $200 for a gasoline motor and $400 for a steam engine, boiler, etc.

There is the cheap automobile. But it is the part of wisdom when the makers of these running gears and wagon boxes refuse to shoulder the responsibility of fitting a motor in their product and by this omission escape all blame for the shortcomings of the automobile-to-be. In this form of business it is taken for granted that: 1, a satisfactory motor and power transmission gear can be procured; and, 2, that the problems of a running gear and a vehicle body suitable for any motor and transmission gear have been solved. Both assumptions are of course radically faulty. If they were not so, the ideal motor vehicle would already be among us. The best that may be said for a motor vehicle built according to this system is that it may not turn out much worse than more expensive automobiles bought in the open market, and that it may be adapted for the first experiments of inventors who have new motors to try.

ECONOMY IN FIRST COST.

From the public's viewpoint the question of economy in first cost is a different one and implies that the complete vehicle shall be known in advance to operate satisfactorily and to be possessed of a reasonable degree of durability. Apart from these requirements, economy has no sensible meaning. With any of the essential conveniences left out which constitute the reasons for using horse and carriage instead of a bicycle, for example, economy takes on a very much restricted meaning, and this applies to motor cycles, to any automobile without baggage carrying capacity, to any automobile requiring special technical education in the operator or caretaker, and to electric vehicles of very limited traveling radius. These are all new commodities, comparable to nothing that has previously existed. They do a new class of work, each of them, by new means, and the idea of economy as here considered, being relative and only intelligible in comparison with earlier methods of doing the same work, is inapplicable. Their economical worth must be judged by new standards drawn directly from the consideration of the special class of work for which they are fitted.

In order to have a clear case the economy of the automobile must be looked upon solely with reference to such automobiles as are intended and adapted to take the place of a horse and vehicle equipment in all respects. Whether other self-propelled vehicles are worth the money asked for them each individual must decide according to his needs, his fancy and his knowledge of what the vehicle will do. If he has had a saddle horse and wants a change, a bicycle is the nearest substitute. It can be obtained at from $25 to $75, and costs practically nothing to keep, but it is impracticable on muddy roads and under certain other conditions. A motor cycle is still more impracticable on muddy roads, but it will go much further and faster than either bicycle or saddle horse on good dry roads. It can easily be arranged to take an extra passenger. It supplies at present a somewhat troublesome and decidedly disagreeable form of locomotion. What this *ensemble* of attributes is worth is an individual question. Comparisons are idle. The cost—$400 to $600—may be low for a fancier and prohibitory for one who wants to cart goods to market. The convenient little electric runabout of recent production, of which the battery weighs less than 200 pounds and may be easily handled, may be excellent and well worth $500 for taking a man to his office or a woman to the shopping district and back, but it is worthless for many other kinds of work for which a horse and vehicle could be used.

It is the full-fledged automobile which is of prime interest. Automobilism will stand or fall with it, economically and otherwise. When perfected its perfection will be the standard from which no downward deviation will be tolerated in any other class of mechanical vehicle. Its speed, now its chief recommendation, will be a mere incident, to be arranged to suit purchasers—a mere matter of power, gearing and strength of material, involving no special engineering difficulties.

In gathering data for forecasting the future price of the full-fledged automobile, one is first astonished at discovering that there are no full-fledged automobiles at present except delivery wagons, electric cabs and carriages, a few drays and here and there a gasoline vehicle with the motor mechanism suspended between the axles under the wagon box. In all others the ordinary vehicle conveniences for carrying goods in addition to passengers have been sacrificed to the necessity of carrying the power source and to the desire for imitating the horse vehicle's outward appearance. They are mere locomotion machines, but not vehicles in the sense of supplying adequate means for carrying, say, 1,000 pounds of baggage if required, as does the ordinary spring wagon.

To remedy this defect is likely to mean additional cost of construction. In the case of some of the electric pleasure carriages the conveniences are equal or superior to those of ordinary carriages of corresponding types—victorias, broughams, hansoms—but with such an addition of weight, causing tire troubles and high operating cost, that the remedy is less acceptable than the defect. The solution adopted in a few makes of gasoline vehicles of hanging the motor mechanism under the wagon box has few advocates, being unsightly and bunglesome for caretaking, cleaning and repairing. But progress seems open in this direction, though on new lines. For light steam pleasure vehicles no remedy worth the name has been discovered. The shortcoming may be considered trifling so long as there are other shortcomings apparently calling for more engineering skill, which must also be removed, but in the competition with horse traction from an economical viewpoint it is not trifling but fatal, and no remedy is in sight short of a radical redesigning of every automo-

bile intended to be more than a toy. Specialties such as physicians' automobiles, solely and exclusively meant for transporting one or two persons, may perhaps be excepted. These represent the cheapest possible construction of an automobile, and this construction being the one now generally adopted, an increase in cost may be looked for when the defect here referred to shall have been removed.

THE EXPERIENCE WITH BICYCLES DELUSIVE.

The popular hope for cheap automobiles rests mostly on the experience with bicycles. On the other hand, sewing machines and typewriters may be cited as commodities in which cheapness is following only very slowly upon extensive manufacture and large competition. If, however, automobiles are to be cheapened it must be through the standardization of certain types of automobiles and the security for large investments in manufacturing plants which such standardization of types will engender. Until the lines of design and construction shall have become fixed and accepted it is reasonably sure that large capital will shrink from the manufacture, especially with the examples before it which the industry affords now of large but apparently premature and unprofitable investments made with the purpose of rushing the manufacture of heavy electric vehicles and light steam vehicles. Yet until capital is freely supplied to organize automobile manufacture economically no great reduction of selling price is to be expected if a margin over the cost of production is to be reckoned with.

While there can be no reasonable doubt that the production of any highly successful type of automobile—and the success well tested out by the public—will be followed by manufacture on a gigantic scale, it is not by any means certain that this will mean a price reduction to the buyer in less than twenty years after the inception of such manufacture. It will beyond all doubt mean a lessening of the cost of production, but it will depend largely on the breadth and validity of patents whether the public will receive the benefit.

In this respect the competition with horse traction is perhaps the only feature which may be relied upon to brighten the horizon and prevent a repetition with automobiles of the scandalous extortions which have been practised in this country with relation to telephone and telegraph service.

AN INCREASE IN AUTOMOBILE PRICES.

Most other data point rather to an increase of automobile prices than the reverse. Among such data are the following:

The price of steam pleasure vehicles is now considerably higher than when the light steam vehicle was first put on the market, it having been found necessary to make the construction more substantial. Owing to the absence of basic patents in steam engine construction and the comparative economy in operation of the larger sizes of engine, there seems, however, to be the best chance that steam automobiles for heavy hauling—sufficiently heavy to warrant the employment of an engineer—will reach an economical basis at an early date. Steam pleasure vehicles will probably hover over the average figure of $1,500, where they practically are today, for some length of time, until gasoline vehicles become so perfected that the much lower cost of operating them—not much more than one to five as compared with steam—begins to depress the price of steam pleasure vehicles, and perhaps forces them out of the market.

The electric storage battery vehicle is intrinsically the cheapest of all to manufacture. The cost of raw material plus the cost of labor figures up lower than for any other automobile. When the patents on storage batteries expire, in a few years, it will be quite possible to make and sell an electric vehicle of the kind now in use and selling for $1,000 for, say, $600 or less, but improved batteries have already been patented which promise less weight and greater traveling capacity, interchangeably. Other more radical improvements are, while not probable, by no means inconceivable. Nothing relating to new means for generating or storing electric energy may be pronounced impossible. But whatever progress will be made is likely to be patented and will, if radical enough to compete with the gasoline motor for general vehicle purposes, render the present form of electric vehicle hopelessly antiquated.

THE HYDROCARBON MOTOR.

The mainstay of all hopes for cheap automobiles is the hydrocarbon motor, with kerosene, gasoline, alcohol or acetylene as fuel. Almost any of the existing models of gasoline motors might be produced in quantities at a cost of less than $100 for a single cylinder five horsepower engine, the material in the rough being worth about $40. Not one of the double, triple or quadruple cylinder motors used in automobiles would necessarily cost more than $200 if produced by economical repetition methods. But not one of them is so near perfection that it may even be thought of as approaching finality. The "overhead" expenses in their production are enormous, unless an artificial halt has been made in progressive construction for purely commercial reasons.

About fifty American manufacturers produce somewhat similar motors for use in boats and thousands of gasoline motors are more or less successfully employed to drive machine tools in factories and dynamos in electric light plants. These motors are sold at good profits and yet at prices that do not seem high, but any argument drawn from this condition in favor of cheap gasoline vehicles—of satisfactory construction—would be sadly at fault.

DIFFICULTIES INVOLVED.

The hydrocarbon or internal combustion motor is generally known to be the most economical power available and the simplest in construction. Unfortunately, however, this power is by its explosive nature as poorly adapted for the work of driving a vehicle as imaginable, especially where crude roads prevail. To make it available even for unvarying work it is necessary to store it first in the rotary energy of a heavy flywheel and then to take the power wanted from the shaft of the latter. This works very well when the power is uniform or of necessity proportionate to the power developed, as that of turning a propeller wheel in water. Still, when the flywheel is heavy enough to absorb the spasmodic power impulses it does not respond promptly to variations in either the work or the power. It takes some time before an adjustment to slow down the motor can take effect. This would be bad for boats and fatal for automobiles. For this reason alone heavy flywheels cannot be used in boats and automobiles, but their size and weight would also prohibit their use. If, on the other hand, the flywheel is small, its stored energy easily becomes insufficient for the work in hand and the force of each explosion takes effect directly in the work, rendering it highly disagreeable for anybody exposed to the jarring.

If the public would accept a form of transportation in which constant shaking of the vehicle is the unavoidable accompaniment of crude construction, there would be no reason why gasoline automobiles should not be sold very cheaply. But the public, in sober reflection, will do no such thing, as long as there are horses, steam and electricity. The majority still believe in the testimony of their senses and cannot remain persuaded that jarring is pleasant and the odor of partly burned gases a delight.

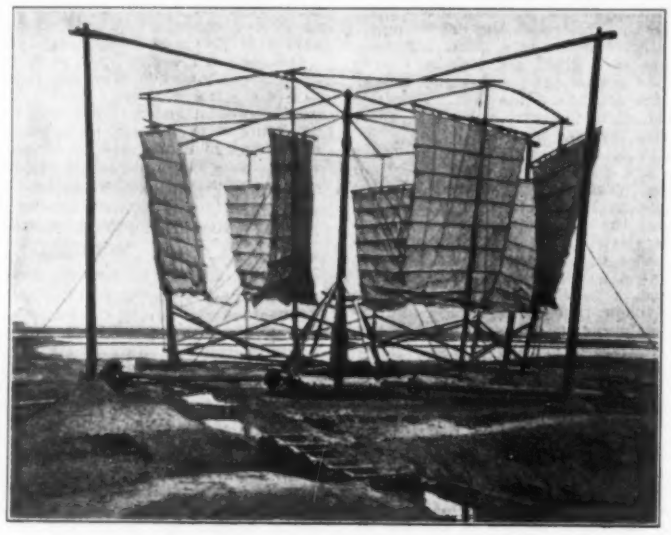
The cost of gasoline vehicles of the highest quality which the present stage of the art affords is mainly that incurred in making a hundred and one more or less efficacious provisions for minimizing, subduing, smothering and absorbing the evil effects of an explosive power by heavy material, fine workmanship, multicylinder high speed motors, ingenious transmission gears, balancing of rotary parts, etc., and the problems involved are so many sided and difficult that the progress made so far looks like a drop in the bucket from the standpoint of a perfectly unbiased spectator.

If the progress were really satisfactory and conclusive evidence of ultimate complete success, steam vehicles could no more be thought of as in the race, and electric vehicles would be at once abandoned to await some revolutionary invention in applied electrics.

The crude gasoline vehicle is cheap, or ought to be cheap—$500—now. The acceptable gasoline vehicle is not yet made, and the creations which come nearest to the ideal conception of the striving engineer are expensive to make, expensive to sell and none too easy to handle. And yet they are the standard bearers of automobilism. Furthermore, they are growing more complicated rather than less so. Refinement spells complication in the gasoline engine as it did in the formative period of the steam engine. Promising improvements are snapped up by large concerns. The possibilities of unpatentable features have been nearly, if not quite, exhausted. The vista of needed improvements presents a deep and interesting but hazy perspective. Automobilism is yet in its infancy.

Cheapness combined with efficiency is not an immediate prospect, but there is compensation in the thought that when cheapness arrives "to stay," it will come in company with all other good and desirable qualities.

In this thesis several apparent contradictions in a brief and brash analysis of a vast subject may be found harmoniously resolved.—The Iron Age.



THE CHINESE METHOD OF OBTAINING SALT BY THE EVAPORATION OF SEA WATER.

SALT MINING IN CHINA.

ACCORDING to Ueber Land und Meer, China obtains most of her salt from the sea. When the allied armies landed at Taku they saw many curious structures, the purpose of which was not apparent.

The structures in question are peculiar windmills which pump water into elevated basins, where it is evaporated by the wind and sun, leaving behind the sea salt. It is true that the salt thus obtained is not agreeable to the European palate. But the Chinese seem satisfied with it, and ship it to Tientsin in loaf-like blocks.

AUTOMOBILE COMPETITION IN 1900.

AT the Vincennes annex, during the Exposition, the Automobile Club of France organized various competitions that furnished data which were very interesting, since they concerned all kinds of horseless vehicles. The award of prizes was based upon consumption, regularity of operation, ease of steering and comfort.

The principal prizes decreed were the following:

Touring Competition.—Carriages weighing more than 800 pounds; 4 classes; 2, 4, 6 or more seats. Five days' tests at 90 miles a day.

Gold plaquettes.—Peugeot, Delahaye, Dietrich, and Panhard-Levassor (gasoline) carriages.

Motocycle Competition.—Duration 5 days; total trip 480 miles.

Gold medals.—Werner motocycle, mean speed 24 miles, consumption about two ounces of gasoline to the mile. Rochet-Petit tricycles and quadricycles, mean speed 22 miles an hour, consumption about three ounces of gasoline an hour.

Competition of Hacks and Delivery Wagons.—The latter carried an effective load of from 1,100 to 2,600 pounds.

Gold Medals for Public Carriages.—Peugeot gasoline victoria; Kruger electric victorias. For gasoline delivery wagons, the Brouhot carriage.

Voiturette Competition.—Distance 480 miles. Two categories: Carriages weighing less than 550 pounds empty, and those weighing from 550 to 880 pounds empty.

Gold and Gilt Silver Medals.—For the first category: Gladiator (Astor motor); mean speed 15 miles, con-

FIG. 1.—DE DION-BOUTON DELIVERY WAGON.

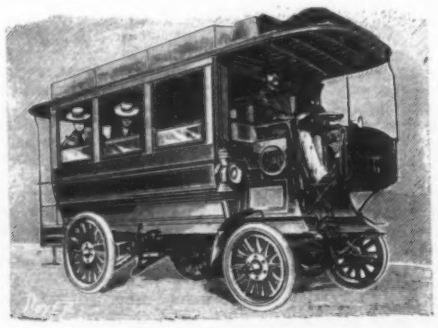


FIG. 2.—PANHARD-LEVASSOR OMNIBUS.

FIG. 3.—PEUGEOT TRUCK.

sumption about three ounces of gasoline an hour. George Richard; mean speed 12.5 miles, consumption 4 ounces of gasoline an hour.

For the Second Category.—Renault Brothers (De Dion motor); mean speed 15.5 miles, consumption 4 ounces of gasoline an hour. Outhenin-Chalandre (De Dion system); mean speed 14.4 miles, consumption 4 ounces of gasoline an hour.

Competition of Light-weight Delivery Wagons.—Six days' test; total distance 184 miles; with tests of consumption; effective load from 220 to 660 pounds.

Gold Medals.—De Dion and Bouton voiturettes (Fig. 1), with an average effective load of 568 pounds; consumption of gasoline about 4 ounces. Peugeot voiturettes, 594 pounds, consumption 5 ounces.

Competition of Heavy Weights.—(1) Omnibuses; daily trip about 42 miles. Gold Medals.—De Dion and Bouton steam carriage; Panhard-Levassor (Fig. 2). (2) Trucks; daily trip 30 miles. Gold Medals.—De Dion and Bouton steam truck. Peugeot gasoline truck (Fig. 3). (3) Delivery wagons. Trips of 30 miles a day. Gilt Silver Medal.—Riker electric carriage.—La Nature.

HEINRICH SUTER'S AIRSHIP.

STILL another aerial navigator has come to the front in Heinrich Suter, a Swiss inventor, who, for the past two years, has been constructing an airship at Arbon, on the Lake of Constance, and that so secretly that no one was aware of his undertaking until he nearly lost his life in the first trial, which was made recently. Suter's machine rose to a height of 150 feet and then became unmanageable and fell. The construction, as our diagram shows, was not without merit.

Although a fairly distinct type in itself, Suter's ship nevertheless bears a certain resemblance to the automobile sledboat of Kress and to the airship of Zeppelin. It is more of a flying-machine than an airship, in so far as the propulsion and steering means are entirely independent of the balloon, which only serves the purpose of balancing the dead weight. The airship is propelled by means of two large screws, mounted beneath the balloon in an open casing. Like most airship constructors the inventor has endeavored to reduce the air-resisting surface of his vessel to a minimum. It cannot be denied that the enormous dimensions of Zeppelin's balloon rendered steering a rather difficult task. Suter's balloon is so connected with the car that it can be turned independently in any direction. Its form is that of the usual pointed cigar, the longitudinal axis of which, whatever may be the direction of flight, will always be turned in the line of the wind, whereby it is possible under certain circumstances that the balloon may assume a position at right angles to the course taken. Evidently the balloon plays no very great part in the construction of the vessel and is merely a lifting contrivance which must of necessity follow the direction taken by the car. Balloon and car are connected by a ball and socket joint which permits any position to be assumed by the two parts. The car is an open frame composed of a few steel tubes, so that the entire resistance of the air is reduced so far as possible.

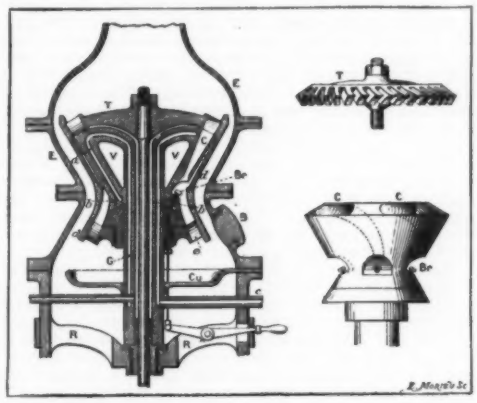
Besides a rigid steering sail or rudder which serves the purpose of trimming the airship in the direction of the wind, the balloon is provided with no special appliances. Compared with other airships the dimensions are small. The length is 23 meters (75.44 feet), of which 5 meters (16.4 feet) are taken up by the nose. The diameter is 4½ meters (14.76 feet). Suter's balloon has a capcity of 296 cubic meters (385 cubic yards), and has a lifting capacity of 350 kilogrammes (770 pounds). Since the car-frame, together with the driving mechanism, weighs but 250 kilogrammes (550 pounds), considerable ballast can be carried along. The interior of the balloon is divided into four compartments held together by a strong silk net—a construction which is not unlike that devised by Zeppelin.

The car-frame, as we have already remarked, consists of steel tubes, which in the opinion of the inventor are preferable to aluminium, for the reason that they impart greater rigidity. Within the car-frame two large air-propellers are mounted, each provided with three blades or wings, and having a diameter of 3 meters (9.84 feet). By means of a very ingenious mechanism these propellers can be adjusted upwardly or downwardly or from side to side. A large vertical rudder mounted without the casing can be circularly swung and can be adjusted at any desired angle, to control the balloon's course. The propellers during the trial were driven by human power. If the machine were to prove successful in every respect, mechanical power was to be employed. The aeronaut who guides this balloon is nothing more or less than an aerial cyclist. Seated in a saddle, his feet upon the pedals, he turns the air-propellers by means of suitable gearing, his one hand regulating the screws, his other hand controlling the rudder. The buoyant force of the balloon is not greater than the efficiency of the air-propellers, so that a descent could be made with power.

This first airship of Suter's was constructed chiefly for the purpose of determining whether or no its underlying principles are correct. The trial has certainly given an answer to the question.

PETROLEUM TURBINE.

MM. PAUL IRGENS and Gerardt Brunn, two Norwegian engineers, have recently devised a petroleum turbine, or, more accurately speaking, a petroleum-gas engine, which is quite original. We shall describe it briefly, with the aid of the accompanying figures, which give a vertical section, as well as the details of the turbine, properly so called, and of the vaporizer.



THE IRGENS AND BRUNN PETROLEUM TURBINE.

Upon the frame of the motor, which is provided with arms, *R*, in the center of which is arranged a bearing designed to receive the vertical shaft, is bolted a jacket, *E*, which is contracted in the middle and expanded above, and terminates in an exhaust serving for the escape of the gases of combustion. At the right, at *B*, is seen a screw plug, the rôle of which will be explained further along. At *V V* is seen the vaporizer surrounding the driving shaft.

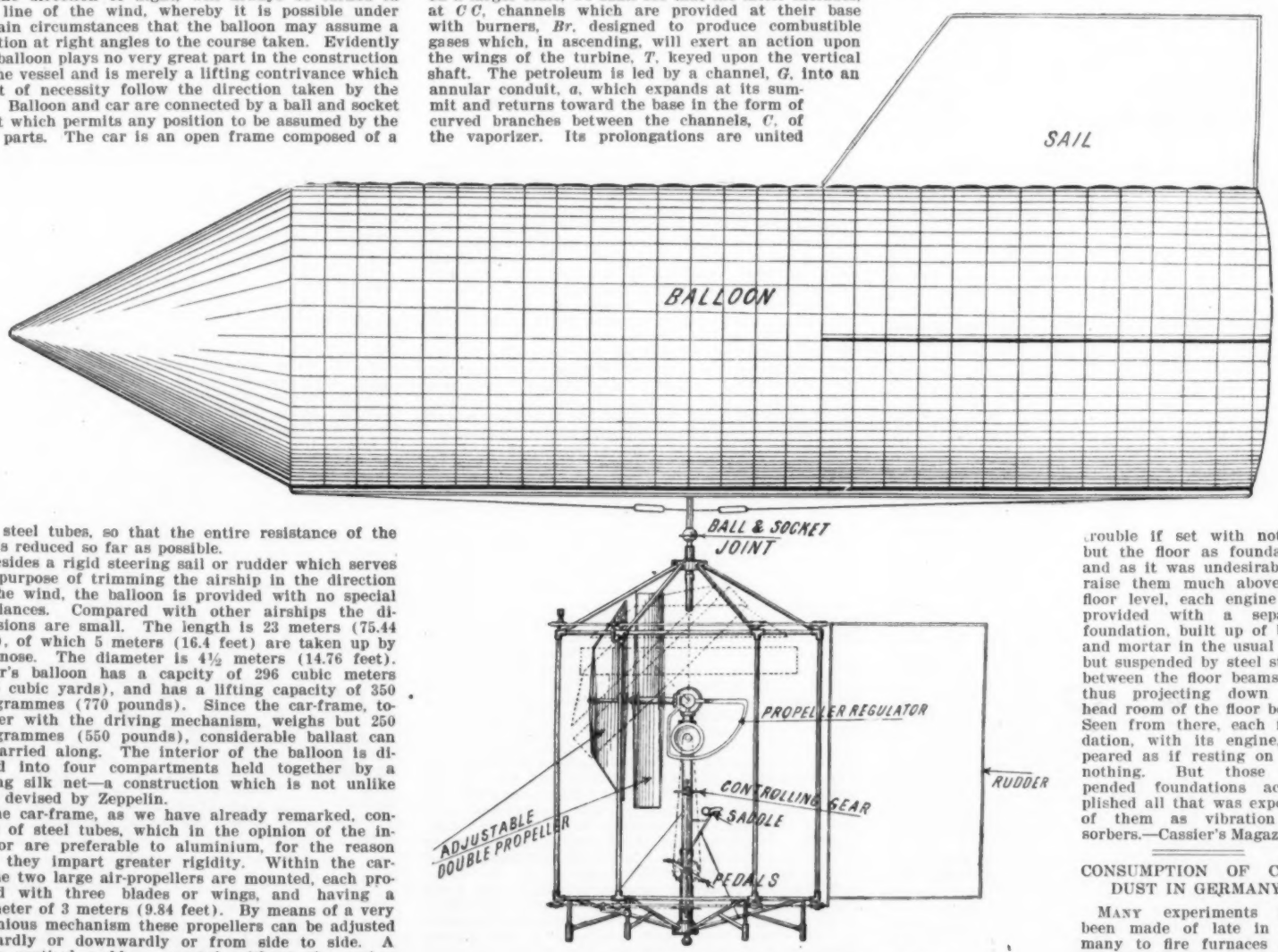
If we examine the figure representing this vaporizer on a larger scale, we shall see that the latter includes, at *C C*, channels which are provided at their base with burners, *Br*, designed to produce combustible gases which, in ascending, will exert an action upon the wings of the turbine, *T*, keyed upon the vertical shaft. The petroleum is led by a channel, *G*, into an annular conduit, *a*, which expands at its summit and returns toward the base in the form of curved branches between the channels, *C*, of the vaporizer. Its prolongations are united at their extremities by an annular space, *b*, with which communicate the burners, *Br*, so that the liquid fuel enters through these branches and vaporizes at the burners. It should be that the latter are placed in recesses and that the channels that debouche just above have a certain inclination, as shown by the dotted lines, in order that the gases developed may strike the wings or blades of the turbine at a certain angle. Without dwelling upon the form of the latter, we may remark that the ring, *d*, which is at its periphery, is provided with wings, *c*, at its base, and that there exists an annular space between it and the vaporizer.

When we desire to start this motor, into which the liquid fuel must be sent under a strong pressure, we pour some alcohol into the receptacle, *Cu*, through the aperture, *B*, from which we have unscrewed the plug, and then ignite it. The heat produced vaporizes the petroleum in the channels of the vaporizer, and the gas that enters the burners ignites. The current of gas then causes the turbine to revolve. The auxiliary ring, *d*, begins to revolve at the same time, and the motion of its wings forces fresh air to the burners, thus assuring a complete combustion of the petroleum gas. The constant passage of this fresh air has, in addition, the advantage of assuring a relatively low temperature in the jacket of the motor. This effect is completed by the space reserved between the ring, *d*, and the jacket, *E*, and the losses due to radiation are thus very small.

MM. Irgens and Brunn's motor has not yet been submitted to a lengthy test, but it is original and interesting, and experiment alone will show the modifications needed in order to improve it.—La Nature.

DEADENING THE NOISE OF MACHINERY.

HAIR felt has repeatedly received mention as a means of deadening vibrations and noise from machinery, placed, for this purpose, between engine bedplates and foundation capstones, and underneath rails subject to heavy train traffic. Now, however, cork is said to have been used in Germany with the same end in view, the available particulars being to the effect that a sheet, made up of flat pieces of the cork, in mosaic fashion, corresponding in size to the bedplate of the noisy machine, and held together by an iron frame, is laid under the machine. What measure of success has been obtained with this new expedient is not told, though, as a means of temporary relief, it probably answered the intended purpose. The true solution of most, if not all, machinery vibration problems is, however, to be found in proper foundations, ample in area and weight, and it generally pays to provide these if at all practicable. To what exercise of ingenuity the engineer is sometimes put in accomplishing this was illustrated a dozen or more years ago in one large factory where, on an upper floor, a row of small engines had to be installed for the independent driving of a corresponding number of different machines. Though the building was of substantial construction, with steel floor beams, it was a foregone conclusion that that row of engines would cause trouble if set with nothing but the floor as foundation, and as it was undesirable to raise them much above the floor level, each engine was provided with a separate foundation, built up of brick and mortar in the usual way, but suspended by steel straps between the floor beams and thus projecting down into head room of the floor below. Seen from there, each foundation, with its engine, appeared as if resting on airy nothing. But those suspended foundations accomplished all that was expected of them as vibration absorbers.—Cassier's Magazine.



THE AIRSHIP OF HEINRICH SUTER.

CONSUMPTION OF COAL DUST IN GERMANY.

MANY experiments have been made of late in Germany to fire furnaces with coal dust, principally with apparatus having some form of fan blower to introduce the fuel into the furnace. It cannot be said that much success has attended the application of these devices. The Schwarzkopff apparatus has, however, according to Consul Hughes, of Coburg, met with much favor in Germany, owing to the facility it affords for utilizing slack or low grade coal. A German Imperial Commission appointed to test smoke-consuming appliances made careful trial of this apparatus, and the report generally is highly favorable. As to the conditions peculiar to the process, it is stated that a highly heated fire chamber is necessary for the ignition of the

coal dust. The higher the temperature, the quicker and more perfect will be the combustion. Contact with the boiler walls interferes with ignition, so that in fitting up a boiler for coal dust firing, some change in the arrangement has to be made. A fire chimney lined with fireproof material has to be provided, because only such a chamber can be kept constantly at the required high temperature. This is most easily accomplished with flue boilers when the flues are lined for a length of from five to eight feet with fireproof material. Metallurgical firings do not offer any difficulty in the arrangement of the fire chamber, because the whole furnace possesses the high temperature required. In these cases the fire chamber can be considerably shortened. The necessity of a fire chamber is not an inconvenience, but a special advantage in coal dust firing, because it ensures a perfect combustion, a high temperature of the gases at the start, and protection against the formation of needle flames. At high temperature, there will always be perfect combustion of carbonic acid gas and water, while at low temperature the more refractory hydrocarbons do not burn at all, or but imperfectly, causing the formation of soot or smoke. Finally these chambers offer for boiler firings, in case of stoppage, the advantage that by the heat stored in the fireproof walls the steam pressure is longer maintained. The apparatus seems also to insure a smokeless combustion.

SUGAR PLANTATION IN HAWAII.

By ENOS BROWN.

HAWAII, the largest of the Hawaiian group of islands, is just now the scene of extraordinary developments in the sugar industry. Lands are rapidly being reclaimed from the tropical jungle which has always encompassed them and prove unequaled in fertility and capable of producing immense crops. Climatic conditions for raising sugar cane in this region are ideal. The requisite rainfall is assured and, free from blight by frost, crops flourish in the greatest luxuriance and profusion. The soil, composed of disintegrated lava enriched by deposits of vegetable decay, is loose, porous, fertile and easily drained. No matter how great the deluge of rain the superfluous moisture is quickly absorbed, leaving the surface and disappearing into the spongy lava rock which underlies the whole superficial area of the island and but five or six feet below.

The Olaa plantation, the last and one of the greatest of the new enterprises, is now grinding its first crop. It is located about nine miles from Hilo and comprises a tract of land four miles in width and fifteen in length. Beginning at an elevation of 200 feet above the sea the land gradually rises until an altitude of 2,000 feet is reached. The surface originally was rolling in places and generally smooth, and but little grading was necessary to bring the land to the required level. In clearing the tract mechanical appliances were employed to demolish trees of larger growth, cables being fastened about the trunks, and, with a stationary engine of adequate power, the tree would be pulled over, the loose soil affording but little resistance. The chaparral was cut down with the ax and afterward gathered into great heaps and burned. The cost of clearing is from $15 to $90 per acre. A 14-inch breaker plow drawn by mules easily tore up the roots, leaving the ground in fair condition for cultivation. A second plowing was sometimes necessary, the land being torn up to a depth of a foot. To fertilize the soil one or two harrowings were given it, and afterward parallel ridges were run across the fields at an average distance of two feet apart, into which the "seed" cane was planted and after quickly taking root the sprouts appear in about three weeks. The greatest enemy of the young cane is weeds, which are kept under only by extraordinary effort. The cultivator is actively employed as long as it can be without injury to the plant, when it is supplanted by the hoe; which is used until the expanding foliage shuts out the sunlight from the ground; the weeds then die and further danger from the encroaching weeds is over. Eighteen months are required to bring the sugar cane to a condition to be ground. In the never-changing season of Hawaii planting is always possible, and is regulated so that grinding seldom ceases. Calculating the length of time necessary to dispose of a crop planted, for instance, in April, the next plants set out will mature at the time the first crop is out of the way. Mechanical ingenuity has not yet devised an apparatus for harvesting the cane. Only hand labor is employed, which is at best precarious and slow. At times the planter is at the mercy of ignorant and inefficient help. As fast as the crop is gathered the land is cleared of the waste, again plowed and planted, and the ceaseless labor of cultivation is resumed. In Hawaii the crop of raw sugar averages from 3½ to 3¾ tons per acre on unirrigated lands. On lands where pumping for irrigation is required from 7 to 12 tons are harvested, but the advantage of the greater yield is largely offset by the serious cost of pumping. Sugar cane is a plant of strong and rapid growth; in Hawaii it attains an average height of six feet in as many months. Canes twenty-five feet in length at maturity have been frequently gathered. The average growth is probably half of this extreme figure.

The average rainfall of Hawaii is 180 inches per annum, equally distributed throughout the year. The sugar cane requires a light, open soil that may be easily drained and a mild and humid climate.

The Olaa plantation has a mill which grinds 200 tons of cane each day or 75,000 tons per annum. The machinery is all of American fabrication.

The most extraordinary feature of this plantation is the source from which it obtains its water supply. The lands are located upon the slope of Mauna Loa, the greatest volcano known. During eruptions of past years great floods of water have been ejected, of such copious volume as to overwhelm and destroy every object in the path of the flood for miles. It was assumed that these waters come from the sea, and no one was disposed to object to the theory until one of the surveyors working on the plantation, observing a little rivulet gushing from the side of the volcano, suggested sinking a shaft and possibly by this means obtaining an increased flow of water, and this was done, when, at a depth of 30 feet, a great reservoir was tapped from which a magnificent flow of pure, cold water, aggregating 15,000,000 gallons a day, issued and has continued to flow undiminished for two years. This shaft is at an elevation of 2,000 feet, which allowed the construction of a chute through the entire length of the plantation down to the grinding mill and furnishes means for the delivery of the cane to the mill by means of gravity alone.

THE GREAT SALT LAKE.*

EVERY year thousands of visitors journey to Salt Lake City. If they have made the journey on the Denver and Rio Grande Railway they have enjoyed the grand views in the wonderful cañons, the ascent of the mountain passes and the glimpses of the barren desert of Eastern Utah. After the journey across the heated desert the descent into the garden spot which the Mormons have created along the shores of the Great Salt Lake is refreshing. The change of scene is like magic, and it seems as if one had entered an entirely different climate.

There are many things of interest—the city itself, the Mormon buildings, the irrigation system by which the desert has been reclaimed, the barren salt marshes skirting the lake and the salt vats upon them, the lake itself salter than the waters of the ocean, and, by no means least, the swim in the tepid lake waters, so dense that one floats in spite of himself.

These and so many other things draw the attention of the visitors so fully that it seems hardly necessary to find anything else of interest; yet the geological history of the region has been so remarkable, and a part of the evidence of it is so plainly seen, that it seems a pity so many should visit the region and return from it without knowing something about it.

This history has been carefully worked out and clearly described by Prof. Gilbert, of the National Geological Survey, in the Second Annual Report of the United States Geological Survey and later in Monograph 1 of the same survey; but even before he studied the region the main facts were known. Indeed, the evidence is so clear that the residents themselves have understood it.

The Great Salt Lake is a very shallow but extensive sheet of water on the surface of a desert plain. Surrounding it in part are mountain ranges, themselves barren and desolate. The lake is nestled in the bottom of a true basin without outlet, a part of the Great Basin. So slight is the rainfall that the basin cannot fill and overflow to the sea. The rain water evaporates in the dry air, and the streams that flow down from the mountains suffered the same fate even before the Mormons came to spread their waters out over the land to transform it from desert to garden.

Each stream on the land gathers a little salt on its journey, and since this cannot evaporate as the water does, it remains behind. From the mountains and from the light rains of the desert enough water is supplied to transform a part of the plain to a lake; but in the dry air the evaporation is so great that only a small part of the supply remains to form the lake. Thus little by little the lake water receives its supply of salt, and therefore becomes salter and salter. This is the cause of most salt lakes.

But the Great Salt Lake has not always been salt. From almost any point in Salt Lake City and along the shores of the lake one can easily detect lines extending along the mountain slopes. They are essentially horizontal, and extend one above the other in parallel belts. It is easy to visit some of these lines; in fact, some of them may be reached by the electric cars. Upon examination they are found to be in the main gravel terraces, linear, flat-topped benches on the mountain flanks, reaching the mountains in the rear and ending in the opposite direction in a steep terrace slope. They are made of sand and gravel with water-worn and well rounded pebbles. Where streams come down from the mountain the terraces broaden markedly, and in places they are partly replaced by steep cliffs of rocks on some projecting spur of the mountain. Such cliffs are usually faced by a narrow terrace of gravel.

The cowboys riding over these terraces recognized them as beaches; early explorers also referred to them as evidence of former higher water in the Salt Lake basin; and Gilbert, as a result of his careful study of them, proved that this interpretation was correct. Any who wish to know the details of this history must refer to Gilbert's works previously mentioned; and I may add that his account of his studies is so clearly and beautifully written that any educated man can read and understand his description.

These ancient shore lines are almost as perfect as one would find along the coast of one of our Great Lakes, if the waters could be withdrawn from it, so as to reveal not only the beaches and cliffs that rise above water, but also the wave-built forms below. The broad terraces opposite the streams are deltas, the narrow terraces are beaches, bars and spits, while the cliffs represent the cutting work of the waves on exposed points. In the arid climate they have wasted away so slightly that they stand to-day in almost as much perfection of form as when the waters first withdrew from them. One cannot mistake their meaning. They tell of a former great lake to which Gilbert has given the name of Lake Bonneville, in recognition of the work of the explorer Bonneville.

When this expanded ancestor of Great Salt Lake reached its highest stage it overflowed across Red Rock Pass, through Marsh Creek Valley into the Columbia, and its waters were fresh. The area of Lake Bonneville was then about 19,750 square miles, and its maximum depth about 1,050 feet, the present Mormon temple now standing where the water was 850 feet deep and the entire lowland in the neighborhood of Salt Lake City being under water.

The tiers of shore lines, together with other phenomena of the region, show that this stage of rise to a place of overflow was but one of a succession of events in the recent geological history of the region. In the first place the basin was dry and contained little, if any, water. The basin then began to fill; but the water did not rise to a point of overflow. Another period of aridity succeeded this, until the basin was again nearly, if not entirely, dry. Then came the rise, which continued until the rim of the basin was reached and an overflow to the sea established. Since then the climate has been growing progressively more arid even to the very present. In fact, it seems from good evidence that the lake is still diminishing in area.

Little can be said about the time involved in these changes. Gilbert finds evidence that the first arid period was longer than either of the two succeeding periods of aridity, and that the second was longer than the present arid period, while the first rise of water appears to have lasted fully five times as long as the second, during which the lake overflowed. What this means in years cannot be stated; but it is doubtless to be estimated in tens of thousands of years. The last rise cannot have been far in the past, for the shore lines which record it are now so distinct; and *all* of the changes belong to the *recent* stages of geological history.

Nor can we at present tell much about the reason for these remarkable changes in climate. The rise of the lake waters represents either a period of greater rainfall, or lessened evaporation, or both; for it tells of the transformation of a desert region of interior drainage to one of sufficient rainfall, or sufficiently diminished evaporation, to permit of overflow to the sea. Not only do we find evidence of vast changes of climate here, but other desert regions, both in the Great Basin and in other parts of the world, tell of similar changes. Enough evidence has been accumulated here and elsewhere to prove that the climate of many regions which we know is different now from what it was in the past, and to give fair basis for prediction that it will be different still in the future.

Whether these changes are due to variation in land level, to the formation or removal of land barriers which interfere with free movement of wind currents, to the changes in ocean currents or to other purely geographic variations, or whether they are to be ascribed to astronomical causes of known or unknown origin, cannot be settled now. Hypotheses are not lacking, and each hypothesis has its advocates; but all are hypotheses still. Man has lived for too short a time on the earth, and the knowledge of fact that he has acquired is far too limited to warrant any conclusion upon this, as upon many other large questions. The *fact* of change in climate must be accepted as a fact amply proved; the *cause* of the change must remain among the great problems for the future to solve.

It is interesting to note, however, that the changes in the climate of the Salt Lake region harmonize with the climatic changes that have been worked out by the studies of the glacial deposits of the East. There were two notable advances of the ice, as there were two notable rises of the lake waters. Not only this, but there is known to have been extensive glaciation among the mountains of the West; and, moreover, that this glaciation occurred at the same time that the lakes were higher. This suggests that whatever caused the glaciation of the glacial period also caused the rise in the lakes. Heavier precipitation in the form of snow among the mountains, and lessened evaporation because of the cold, would suffice to account for the rise in the lake; but this does not remove the difficulty of accounting for the changes, for what caused the heavier precipitation in the form of snow and the greater cold?

There is evidence of other interesting changes in conditions registered in this field. During this lake history volcanoes belched forth lava and ashes, and some of them have been active so recently that their cones and lava flows are still fresh, as if just formed. At present there are no active volcanoes within a radius of thousands of miles. There is also evidence that the level of the land has changed perceptibly since the water left the last beaches. If the basin should again fill, the water level would not coincide with the beaches previously formed. They have been deformed and broken here and there so that they are no longer horizontal, as they were when built. That is to say, the mountain growth had not ceased when the lake beaches were built.

Such facts as these teach us that the earth is unstable and the seat of change. What we see to-day is not what would have been seen in the past, nor probably what will be witnessed in the future. The maze of evidence of such changes is constantly being increased as time passes, and as the work of the army of investigators proceeds into new regions and increases in detail in better known sections. The facts that are gathered cannot always be understood nor their full meaning be interpreted, and this sometimes seems discouraging to those who are working and discovering them; but little by little the earth history is being interpreted, and every year sees progress made. Many more facts are needed, and many men are patiently gathering them. When the facts are all in, the explanation will be at hand; but until that time, we must rest content to allow some things to be mystery. When the deposits of glaciers all over the world have been carefully studied, and the changes in climate of all the arid lands of the continents have been fully determined, we may hope that even the mystery of the transformation of temperate regions to ice fields and of arid deserts to lake-dotted, verdure-covered lands will cease to rank as mystery.

* By Ralph S. Tarr, Professor of Physical Geography in Cornell University, in the Independent.

TABLE-GLACIERS OF THE ANTARCTIC REGIONS.

M. HENRYK ARCTOWSKI has lately given an account of the Antarctic glaciers as observed during the recent voyage of the "Belgica." The icebergs of the Arctic regions have a great variety of forms and are generally of small size; however, icebergs of 250 feet high have often been measured, and according to M. Drygalski they may attain a height of 350 feet above the sea-level. The table form has been rarely observed in the Arctic regions, although near the glaciers from which the icebergs are derived they present themselves under this form whenever the slope of the glacier is small, and the icebergs which break off remain in their position of equilibrium. In the Antarctic regions this case, which is exceptional for the Arctic regions, seems to be the general rule, for it is especially the great tabular icebergs which have been noted. These great ice-tables of the Antarctic seas attain very large di-

mensions. Icebergs have been frequently met with which were from one to two miles in length and whose height reached 180 feet above sea level. In the region sailed over by the "Belgica" the voyagers sometimes saw as many as 110 at the same time in the circle of the horizon. About 40 per cent of these had the characteristic table-form, while the greater part resembled the Arctic icebergs, or mere modifications of the table-form. The larger icebergs were rare; those reaching 150 feet high were exceptional. The tabular icebergs were more frequently 90 to 120 feet in height. They only show the clear ice at the lower part, and this takes the form of alternating blue and white layers. The author could only examine this stratification near by in a single case, that of an iceberg imprisoned in a bank of ice; it was partly tilted over, and the strata were in an inclined position. The blue bands, as well as the white, were composed of ice having the characteristic glacier grain. The strata were not very sharply defined, and the only difference between the blue and white bands was that due to a porous structure in the white portion, the latter containing a much larger quantity of air bubbles. Both strata were, however, formed of compact ice. The supposition that tabular icebergs are formed of sea-ice is therefore quite erroneous. Besides, the mode of formation of sea-ice shows that its increase of thickness tends toward a limit, which Weyprecht supposes to be 22 feet at most, however low may be the mean winter temperature and however great the number of years of formation. The author thinks that for the Antarctic region this figure is even too high. Again, the continental origin of the Antarctic icebergs is beyond question, seeing that the bottom of the Antarctic Ocean is covered with sediment and erratic blocks which must have been deposited there by the successive melting of the icebergs. The most of the great glaciers of the Antarctic regions have a slope which is sufficiently small to produce the tabular icebergs; nevertheless, it is probable that the greater part of the ice-tables come, not from the glaciers proper, but from the great sheets of ice which form the *inlandjis* of the lowlands. The author considers that 150 feet is the maximum height of the table icebergs coming from the great ice-wall which extends to the east of Victoria Land as far as the 175th degree of west longitude, and which no doubt continues toward the east to the regions situated south and west of Alexander Land, as the observations made during the trip of the "Belgica" seem to have shown.

LIVING MILLSTONES.

By R. LYDEKKER.

THE mill-like action of their own upper and lower molar teeth upon one another may have been quite sufficient to suggest to our prehistoric parents the idea of opposing a pair of corrugated stones in such a manner that by mutual rotation or revolution they should be capable of reducing to powder hard substances placed between them. Indeed, the idea of millstones is such a simple and natural one that it is quite probable it may have occurred to the human mind without reference to any prototype in nature; and, in any case, if such a natural prototype is to be sought, it is not necessary to go further in search of it than our own dental organs. Excellent, however, for their special purpose as are these organs (when not subject to premature decay), there are other types of tooth-structure to be met with in the animal kingdom which present a much closer approximation to millstones, and might well have foreshadowed these instruments, had they only been accessible to the primeval savage. But since these natural millstones occur only in marine fishes, some of which inhabit distant seas, while others are met with only as fossils deeply buried in the rocks, it is evident that the idea of artificial millstones is not derived from these natural prototypes. In other words, to use an expression now fashionable in natural science, the development of artificial and natural millstones is a case of parallelism.

In spite of the fact that their early ancestors were provided with a good working set of sharply pointed dental organs, birds in these degenerate days manage to get along without teeth at all. A few mammals, too, like the South American anteaters, are in the same condition; and some people have thought that in a few more generations civilized man himself will be reduced to the same toothless state. The great majority of mammals, however, possess a more or less efficient set of teeth, varying in shape, size, and number according to the need of each particular species or group. But there is one feature common to these organs in mammals of all descriptions; and this is that they are strictly confined to the margins of the jaws, never extending either on to the palate, or to the space inclosed between the two branches of the *lower* jaw. In many reptiles, such as crocodiles and a large number of lizards, the same law of dental arrangement obtains. In some lizards, and still more markedly in certain extinct members of the reptile class, we find, however, a number of teeth developed on the palate, having flattened crowns, and thus tending to make the mouth act the part of one large millstone. But we must descend a stage further in the scale of animated nature before we come to structures which are strictly comparable with artificial millstones and crushing cylinders. And it is in the class of fishes that we meet with these organs in the full perfection of this type of development. Not that they occur by any means in all the groups of that class; the fact being that at the present day living millstones are going out of fashion, the great preponderance of modern fishes having their dental armature mainly restricted to the margin of the jaws, with or without a minor development of crushing teeth on the palate or the bones of the gullet. With the exception of a comparatively limited number of cases, showing a different type of development, to which it is not my present intention to allude, these dental millstones are confined at the present day to those hideous marine fishes commonly known as skates and rays, and to the singular Port Jackson shark and a few allied species inhabiting the Pacific and Malayan seas. On the other hand, the seas of the Cretaceous, Jurassic, and antecedent epochs absolutely swarmed with numerous kinds of sharks, more or less nearly related to the Port Jackson species, whose mouths were filled with pavements of teeth showing marvelous variety of structure and beauty of ornamentation. The skates and rays, too, displayed types of dental millstones quite unlike any of those of the present day. And in addition to these, there were hosts of enamel-scaled fishes whose mouths were likewise crammed with beautiful crushing teeth, albeit of a totally different type of structure to that obtaining in either the sharks or the rays. Although well nigh extinct, these enamel-scaled fishes are still represented by the bony pike of the rivers of North America, and the bichir (remarkable for its fringed fins and the row of finlets down its back) of tropical Africa. But it is noteworthy that in neither of these survivors of an ancient group do we find the mouth furnished with an apparatus of millstones; while, as already said, among the host of sharks that infest the warmer seas of the globe it is only in the Port Jackson species and its three kindred that we find similar structures retained; all the other members of the group having developed cuspidate teeth adapted for seizing and tearing soft-fleshed prey, instead of for grinding up mail-clad food.

Clearly, then, there has been some general cause at work which has rendered crushing teeth, so to speak, unfashionable among the fishes of the present day and the immediately antecedent epochs. And in this connection it is important to notice that there has been an even more strongly marked tendency to the extinction of the enamel-scaled fishes, and their replacement by the ordinary soft-scaled fishes so abundant in the present seas. As the majority of these old mail-clad fishes, as well as a large proportion of the ancient sharks were provided with crushing teeth, it is a fair inference that their food consisted largely of shell-fish and crustaceans with a certain proportion of their own mail-clad relatives. When, however, the swift-swimming, soft-scaled fishes came to the fore, they would naturally offer a more tempting and nourishing diet to such sharks and other predaceous members of their own class as were swift enough in their movements to make them their prey. And consequently the old millstone-jawed sharks would tend to more or less completely disappear. On the other hand, the skates and rays, which are for the most part slow-moving creatures, flapping sluggishly along on the sea-bottom by means of their fan-like fins, would be quite unable to capture the modern type of swift-swimming fish. And they have thus had to content themselves with the old-fashioned diet of shell-fish and crabs, in consequence of which a large proportion of them have retained the dental millstones which have been so steadily going out of fashion among their more advanced relatives. Not that these rays and skates have by any means been content with the kind of molar machinery that did duty for their forefathers, since some of them, together with their Tertiary ancestors, have developed what appears to be absolutely perfect type of living mill, far superior to that which served the purpose of their predecessors. And it must always be remembered that these beautiful living millstones and cylinders (which are some of the most exquisite bony structures to be met with in the whole animal kingdom) excel their artificial substitutes in that they never wear out; being renewed either by the development of new teeth on the inner or hinder aspect of the cylinder, or by vertical successors replacing the individual teeth from below or above.

And now that the dental millstones of the rays have been mentioned, it will afford a convenient starting-point for a brief survey of some of the most remarkable types of structure presented by these curious organs.

The teeth of rays always form a pavement-like structure, of which the component elements are arranged in straight longitudinal rows, although they may likewise show a quincunxial mode of arangement. The individual teeth are not replaced by vertical successors; but being in the form of a half-cylinder, as those in front become worn down, the whole series is pushed forward, and new teeth are developed on the hinder margin of the cylinder. The supreme development of a dental structure adapted for crushing in this group occurs in the family of the eagle-rays (*Myliobatidæ*), in which the millstone of each jaw forms a perfect semi-cylinder or plate, made up of flat-crowned prismatic teeth united at their edges, often so as to constitute a mosaic-like pavement. No piece of modern machinery can be better adapted for crushing hard substances than are these beautiful ivory cylinders and plates, the crushing power of which, when worked by the strong jaws, must be enormous, and sufficient to grind the strongest shell that can be introduced between them to powder. Although in all cases pavement-like, the millstone differs considerably in the different species in its structure. As an illustration of the group we may take one of the millstones of the beaked eagle-rays (*Rhinoptera*). Here the millstone is in the form of a semi-cylinder, consisting of five or more rows of teeth; a very usual number being seven. Generally the teeth of the middle row are the widest; those of the rows on either side being considerably narrower; while the two or three marginal rows on each side may be compared to the tesseræ in a mosaic pavement. A further development of the same type is exemplified by the typical eagle-rays (*Myliobatis*), in which the middle row of teeth in the millstone becomes still wider, while the three lateral rows on each side are reduced to the condition of hexagonal tesseræ. Moreover, whereas in the species of *Rhinobatis* both millstones are in the form of half-cylinders, in *Myliobatis* the upper one alone retains this form, the lower being a flattened plate. The culmination of this type of structure is displayed in the rays belonging to the allied genus *Aëtobatis*, in which both upper and lower millstones are flat and composed only of the middle row of teeth, which are of great width; the lateral rows having completely disappeared. The existing representative of this genus is not very large (for a ray), seldom if ever measuring more than about five feet across; but some of its extinct predecessors must have been monstrous fish, as the teeth measure five or six inches in diameter.

Quite a different type of dental armature is presented by the millstones of the beaked rays (*Rhinobatidæ*). Here the teeth take the form of closely packed diamond-shaped knobs, arranged in an alternating manner, so that although they present longitudinal rows, yet they also show oblique series, so as to give rise to a quincunxial pattern. Then, again, the entire millstone in each jaw is thrown into a series of undulations, so that the upper one exhibits a large median boss, flanked by a pair of smaller undulations, which are received into corresponding depressions in the lower millstone. It is difficult to conceive a machine better adapted for crushing than is presented by the jaws of the beaked rays.

Of a much less powerful type are the millstones of the ordinary rays or skates (*Raiidæ*) of our own coasts; and among these the common thornback (*Raia clavata*) presents a very remarkable condition, since the individual teeth take the form of obtuse knobs in the female, whereas in the male the center of each of these knobs acquires a sharp recurved point. Since every thing in nature has a meaning, it would seem a fair inference that there must be some important difference between the food of the male and female thornback, but I have not come across any observations bearing upon the subject.

Among the fossils to be obtained occasionally from the workmen in large chalk-pits are teeth of a peculiar type. These teeth form convex quadrangular bosses, the marginal portion of which consists of a broad granular area, while the center is occupied by a variable number of bold ridges, or folds, between which are often irregular knobs. It is from these ridges that the fish take the name of *Ptychodus*. For a long time it was uncertain how these teeth were arranged, but careful comparison of a number of more or less incomplete series *in situ* has at length solved the problem. In the lower jaw the complete millstone was formed by a median row of large teeth similar to the one figured, on each side of which were six or seven other rows composed of teeth gradually decreasing in size from the center to the margin. In the upper jaw, on the other hand, there was a central row of small teeth, flanked on each side by a row of large ones, externally to which came a series of rows gradually diminishing in size. From this mode of arrangement it is inferred that *Ptychodus* was a ray; and the whole dental structure is as remarkable for its perfection as a crushing machine as it is for its intrinsic beauty.

Even more elegant from an æsthetic point of view are the "millstones" of the Port Jackson shark (*Cestracion*) and its allies. In place of forming a continuous plate across the palate after the fashion of the eagle-rays, the individual teeth in this group are arranged in oblique bands round the edges and inner sides of the jaw,* showing in the hinder region a melon-shaped swelling of remarkable gracefulness, which would form an attractive ornament for the capital of a pillar. In this melon-like portion of the millstone the individual teeth form bluntly convex oblongs; those of one row being markedly larger than all the rest, while the rows in front of and behind this do not correspond with one another in size. Examined with a lens, each of these blunt teeth is seen to have a minutely pitted structure, while its median longitudinal line is marked by a narrow smooth streak. New teeth are being continuously produced on the margin of the series on the inner side of the jaw, and as the outer ones become worn away, the whole series is pushed over toward the edge of the jaw. Proceeding from the larger rows of teeth toward the front of the jaw, it will be seen that as the individual teeth become gradually shorter their smooth median line gains prominence, till it finally develops into the sharply pointed cusp surmounting each of the front teeth.

As already stated, the Port Jackson shark, and a few other nearly related species (all of which, by the way, feed on shell-fish and crustaceans) are the only sharks with millstones met with in our present seas. And it is fortunate that these have lived on, as otherwise we should never have gained a true idea of the dental armature of their extinct relatives which abounded in the seas of the Jurassic epoch. Visitors to Whitby must be familiar with certain black oblong fossils of about an inch and a half in length known to the quarrymen as "fossil leeches." These are the hinder teeth of an extinct shark (*Asteracanthus*) nearly allied to the Port Jackson species, but of much larger size; and although they are more rugose than pitted, they show the same smooth line on the summit. A beautiful specimen from Caen, in the British Museum, shows that the arrangement of these hinder teeth was almost exactly the same as in *Cestracion*, which may thus be regarded as a survivor from a long past epoch of the earth's history.

But there were other "millstone-mouthed" sharks at a still earlier period which appear to have been allied to *Cestracion*, although the degree of relationship is uncertain. In these Palæozoic sharks, as exemplified by *Cochliodus*, the series of hinder teeth seem to have had an arrangement very similar to that obtaining in *Cestracion*, but the individual teeth of several series were more or less completely fused into a single solid plate, the ridges on which mark the original lines of division between the component series. These sharks exhibit, therefore, one among many instances where the earlier forms of a group are in some respects more specialized than their descendants.

So much space has been taken up by the rays and sharks that only a few lines remain for the millstones of the enamel-scaled fishes. In none of these do the teeth, which are developed on most of the bones of both the upper and lower jaws, ever form continuous plates; and they are generally either spherical or kidney-bean-shaped, and arranged in more or less distinct longitudinal rows. Unlike those of the sharks and rays, these teeth, as in the familiar *Lepidotus* of the Wealden, are replaced by vertical successors; and their mode of development is so peculiar that in some cases the new tooth is placed wrong way up beneath the one it is destined to replace. In other instances, as in *Calodus*, from the Folkestone Gault, successional teeth have not been

* Strictly speaking, the tooth-bearing cartilages of sharks are not true jaws.

observed, and the mode of renewal is consequently still unknown. Although within the limits of a single article in Knowledge it is impossible to do more than give the crudest sketch of a vast subject, yet what has been written may be sufficient to attract my readers' interest to an extremely fascinating branch of zoological study.

A REPORT CONCERNING THE CATTLE OF PORTO RICO.*

PURSUANT to authorization from the honorable the Secretary of Agriculture and your instructions of March 27, 1899, to proceed to the island of Porto Rico for the purpose of making investigation concerning the existence of Texas fever infection and to note incidental observations of interest to the Bureau of Animal Industry, the following report is respectfully submitted:

On April 11 I arrived at San Juan, and since that date have visited practically all the cattle districts of the island of Porto Rico. From the most reliable information obtainable, I judge the number of cattle on the island to be 500,000, the majority of which are in the coast country, although there are small bunches and individual animals scattered throughout the mountainous interior. The predominant color is solid light yellow; some are black, others white and black, and but few roans and reds; many have dark muzzles, ear tips and legs. The hair is short and glossy; some are almost devoid of hair on the belly and inside of the thighs. The horns of many are inclined to unusual elevations and the ears droop. The color, the round, clean-cut straight limbs of many of the young animals and their well-rounded bodies with elevated heads and spike horns close together remind one of the antelope of our Western plains. The cattle of this island are usually in good flesh throughout the year. During April and May were seen numbers of four or five year old steers ready for export which averaged 950 pounds, and which had never received food other than that afforded by the native grass pastures. Older oxen far exceed the weight mentioned. They are all of the same general type, being descendants of the old Spanish stock with the infusion of African blood. The latest African importation was in the year 1834 and consisted of five Senegal bulls brought by Señor Casinus Laporte, of Ponce. It is said that two Swiss and four English cows were brought to this island in the year 1864, later data of which is unattainable. For at least during the past century the deleterious effects of inbreeding have obtained, and are decidedly in evidence in the cattle of the island.

Cattle are the universal burden carriers. They are hitched to immense two-wheeled carts by a crude yoke which rests on the poll and is lashed to the base of the horns. They haul all freight between the ports and the interior. Therefore, if the dangerous tick exists at all, the opportunity for the spread of infection is most favorable. The annual increase is 95 per cent of the sexually mature females; and, as the island is free from wolves, coyotes, and allied foes of young live stock, the small percentage of loss is confined to the usual accidents incident to birth and to a large spider, the bite of which occasionally results in death.

Porto Rican cattle as a rule are very tractable, being accustomed to grazing at the end of a rope or otherwise handled by attendants. On the east coast I have seen more than a hundred head on a small tract of land where the grass, similar to Johnson grass, was higher than their backs, and so thick that it was with difficulty that our saddle ponies could make their way when away from the beaten paths. Each animal was tied to a bunch of grass by means of a rope about 25 feet long made of bark. This circle of 50 feet in diameter would suffice for many days' full rations. At no time of year are the cattle housed; except in a single instance, where there was a mere shed for protection from the sun, I found no pretense for cowbarn buildings.

But little attention is given to the matter of improving the stock, either by the introduction of new blood or the selection of the best native individuals for breeding purposes. The steers have a staggy appearance, for it is the custom to allow all male animals to reach sexual maturity in the herd. In view of these facts there is no great wonder that the size of the cattle and the distribution of flesh on the animal frame do not approach the standard for beef breeds, or that the milk secretion is scanty. The ill effects of inbreeding and general injudicious handling must be in part counteracted by the natural favorable conditions of the island, which insure nutritious grasses and equable temperature throughout the year.

Judging from general appearance and from the fact that some 400 head of native cattle at the United States vaccine station, at Coama Baths, Porto Rico, were tested with tuberculin with but 1 per cent reacting, none of which were found upon post-mortem to be diseased, I conclude that there is but a small percentage of these cattle affected with tuberculosis. The bacilli of tetanus and blackleg have a general distribution. Deaths from these diseases occur annually in different parts of the island. Minor surgical operations have been so frequently followed by tetanus that the use of the knife in castration has been discarded, and, as prevention against invasion by germs and annoyance by flies, a rather imperfect form of castration is accomplished, either by bruising the testicles or by rupturing the spermatic cord by torsion and tension without incising the skin.

From the reports of cattle owners it appears that exceptional conditions on this island produce annually a few well-marked cases of Texas fever. Ticks are the greatest enemies of these cattle. In all localities they were found infested with ticks, always apparently of the same species, numerous specimens of which were mailed to the Bureau of Animal Industry. If it is proven that this tick is capable of transmitting Texas fever, there can be no doubt that all Porto Rico teems with the contagion of Texas fever throughout the entire year, and that no cattle could depart from or be brought into the island without contact with such contagion.

I desire to acknowledge in this report the valuable

STREET IN AIBONITO, PORTO RICO, SHOWING METHOD OF YOKING OXEN.

OXEN AND CART, NEAR AIBONITO, PORTO RICO, SHOWING METHOD OF YOKING OXEN.

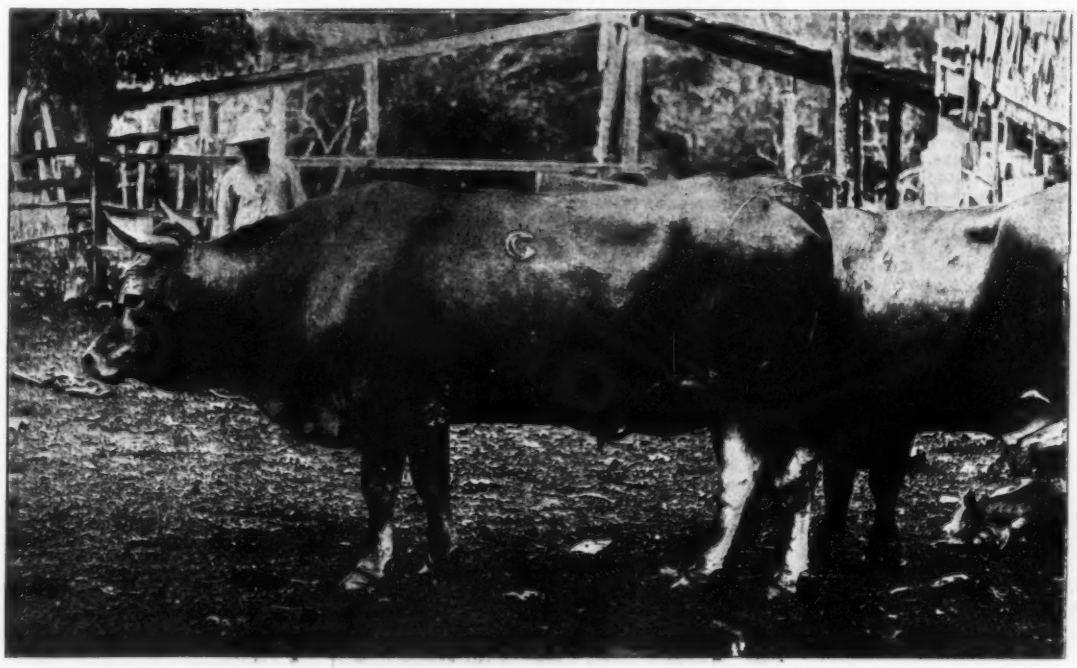
* By Rice P. Steddom, Inspector, Bureau of Animal Industry, Department of Agriculture, and forming part of the sixteenth annual report of the Bureau of Animal Industry.

service rendered by Mr. Simon Moret, of Ponce, and the courtesies of the War Department extended through Dr. Major Azel Ames during this investigation.

DESTRUCTIVE INSECTS, AND INSECTS AS ETIOLOGICAL FACTORS IN DISEASE.*

THE lecture will be on insects as etiological factors in disease; or, in other words, insects in relation to the causation of disease and also in the distribution of disease. This subject has come into prominence quite recently, although it is by no means new. The Spanish-American war and the South African war called attention particularly to this subject in relation to certain parasitic diseases among the troops. A knowledge of this subject was quite long in growing, and has been built up from early time; so that in the present day we have a fairly accurate knowledge in regard to the subject in a general way, although there are a great many minor details to be worked out.

DAIRY CATTLE, BESOSA ESTATE, AGUIRRE, PORTO RICO.



A NEAR VIEW OF PORTO RICAN STEERS.

We may begin with Anaximander, of Miletus, Greece (born in 610 B. C.), who held that animals were formed from moisture. This is probably one of the first records to account for the existence of organized creatures. Empedocles (who lived about 450 B. C.) attributed to spontaneous generation all living things. This idea of spontaneous generation was held for a great many years. Aristotle (born 384 B. C.) asserts that "sometimes animals are formed in putrefying soil, sometimes in plants, and sometimes in the dust of other animals." Of course, these theories are ridiculous. He also held that every dry substance which becomes moist, and every moist body which becomes dry, produces living creatures. Of course, that is not true at all.

The first rational idea of the lower forms of life was given about the year 1618. Prior to that date it was supposed that all small animals were spontaneously generated. For instance, eels were supposed to be generated from the slime of the Nile, and maggots to be spontaneously generated in meat. The physician to the Grand Duke Ferdinand II. and Cosmo III. of Tuscany addressed himself in 1618 to this matter. He had seen the maggots in putrefying flesh, and reflected on their possible origin; but he was not content with mere reflection over the theoretic guesswork that his predecessors had founded on imperfect observation. Watching meat prior to the appearance of maggots, he invariably observed flies passing around the meat and frequently alighting upon it. The maggots, he thought, might be the half-developed progeny of flies. The idea or theory, of course, precedes experiment, by which, however, it must be finally tested. He knew this, and acted accordingly. Placing fresh meat in a jar and covering the mouth with paper, he found that though the meat putrefied in the ordinary way it never bred maggots; while the same meat placed in open jars soon swarmed with these organisms. For a paper cover he substituted a fine gauze through which the odor of the meat could rise; over it the flies passed and over it they laid their eggs; but the meshes being too small to permit the eggs to fall through, no maggots were generated in the meat, but hatched on the gauze. This destroyed the idea of spontaneous generation of maggots in meat and in other things. These were the most interesting and extraordinary experiments made in early times; and it shows the value of direct experiment and the wonderful results accruing from it. This physician practically destroyed all the absurdities and crudities of belief that had filled the minds of his predecessors for so many years.

Of course, that relates to the origin or to the breeding of insects; but to understand thoroughly this question of the propagation of disease—of the carrying of disease by insects—it is necessary to know something in regard to the lower forms of life known as germs or bacteria. In 1862 Pasteur proved that many floating particles in the air were organized bodies. This was an exceedingly important discovery, not only in medicine, but in science generally. Up to that time it was thought that all these small, dust-like particles that are seen under the microscope were simply dust, or matters of that character; but Pasteur, the great French scientist, proved successfully that these particles were organized bodies.

In 1836 Chevreul and Pasteur proved that animal solids did not putrefy or decompose if kept free from the access of germs. This was also an important discovery, because it showed why meat and other articles of a similar character became putrid and why decomposition took place due to these lower forms of life called germs. In 1873 Obermaier observed that spirilla (flexible, spiral organisms) were present in large numbers in the blood of patients in relapsing fever. This was one of the first discoveries in regard to the propagation of disease by these lower forms of life. In 1882 Dr. Koch discovered the Bacillus tuberculosis, the cause of consumption. In 1884 he discovered the Cholera bacillus; and I may say that since that time it has been proven successfully that a great many diseases are due to these lower forms of life. In 1894 Yersin and Kitasato independently discovered the bacillus causing the bubonic plague. One of these discoverers was a Japanese.

The cause of these various diseases is a bacterium; and a bacterium, or bacteria, as they are called in the plural, are minute vegetable organisms. They are lowly organized plants—some of these plants motile, having waving filaments called cilia or flagella; and some of them swim about in fluids, and they are said to look like microscopic serpents. Of course, they are exceedingly small; the unit of measurement for bacteria is one micromillimeter, or the one-thousandth of a millimeter, and this is equal to about 1-25,000 of an inch, so that you can see they are very minute, and it requires high powers of the microscope to differentiate them. They multiply by fission, or spores, or seeds, or eggs as they might be termed. One of the methods of multiplication (take a rod-like bacterium like that exhibited) is simply to divide; that is called fission. In three days, by this process of fission, from one bacterium there would be produced 4,772,000,000,000 germs; so that it can be readily understood why the human body in some instances is quickly overwhelmed

* A lecture delivered at the Academy of Natural Sciences of Philadelphia by Prof. Henry Skinner, M.D., Conservator of the Entomological Section. Specially reported for the SCIENTIFIC AMERICAN SUPPLEMENT.

with this enormous production. Then there are certain other forms of these organisms called micrococci. This really is a compound word, and means little berries. These germs look like little berries, while the bacillus is a rod, or rod-shaped. And then there are certain of these organisms called spirilla (or corkscrew-shaped). They are found practically everywhere except in the atmosphere of very high mountains, and they are not plentiful at sea—the air in both places being very pure. They are not normally found in the tissues of animals. If found in such places, they are signs of disease.

Of course, they are plentiful in stagnant pools of water and in the upper soil, or, in fact, wherever decomposition is taking place; so it can be seen how important it is to keep everything clean and to do away with all such places. A great many people are afraid of these lower forms of life, and of course it is natural that such is the case when we know how many of them are really injurious; but the great majority are beneficial in various ways. Those that produce disease are called pathogenic germs, and they get into the body by the digestive tract, the respiratory tract, through the skin and mucous membranes, and by abrasions and wounds; so that you can understand by this how they can be carried into the human system by insects. For instance, the insect can carry these forms of life on to food, and they get into the digestive tract in that way; or they may abrade the skin by bites, as by certain biting flies or mosquitoes; and these forms of life are carried into the general circulation and breed disease in this way. It may be asked why everyone does not acquire these things. For some unknown reason there is a condition of immunity and a condition of susceptibility. Some people don't get certain diseases; it may be that they have had them at some time in their life, and may become immune in that way. If a number of people are exposed to the contagion of typhoid fever, for instance, it is probable that only a certain percentage out of the entire number will get it; and this is a very wise provision of nature; it tends to preserve the species. If everyone should get the disease and every one should die, the human species would cease to exist, and in all probability there is an absolute law of immunity; that is, it is a comparatively fixed percentage; and that explains why all people or all persons at a time do not get these germ diseases.

At the present time in India there are epidemics or endemics of bubonic plague. It is an exceedingly fatal disease, and it has been fairly well demonstrated that one of the methods by which this disease is carried is by the agency of insects; flies, fleas and animals of that character carry the disease about; also rats and roaches are known to carry it. For instance, flies have been crushed in bouillon, and these bacteria that cause the disease (the bacilli) have been found in the bodies of the flies. The bacillus of the bubonic plague has been found in such animals; and if flies are fed with infected mice which have died from the plague, the flies take the plague and die also; so we know now that flies and other insects carry this disease. The disease is a very fatal one, and in one year, or in a comparatively short time, in Europe 3,000,000 died of it, while within the period of recorded history it is estimated that 25,000,000 there died of it, and in India at the present time a great many people have succumbed to this disease.

The bacillus of the plague has also been found in fleas and on diseased rats. The rats are perhaps a common carrier; and it is said when the rats are found around the dead or dying that the plague is about to be seen; and it is also distributed to various countries by rats in the holds of ships. Fleas crushed and injected into a mouse produce death in the mouse from the plague. It has also lately been observed—rather, the discovery confirmed—that yellow fever also is in addition to malaria carried by mosquitoes. Some of the government surgeons in Cuba lately have performed some very interesting experiments with mosquitoes belonging to the genus Culex. They allowed these mosquitoes known to be infected with the bacillus of yellow fever—the Bacillus ichtheroides—to bite people. Eleven persons were bitten by these mosquitoes, and out of the eleven three died—one of the persons dying being an assistant surgeon in the United States army and one of the authors of the paper describing these experiments. Of course, the people that were inoculated by mosquitoes with the disease were volunteers, and those that died were martyrs to science.

These diseases are carried by various kinds of insects—not all insects, by any means—and particularly or almost entirely by those that bite; for instance, the flies, and bugs including the sucking insects. The bees and wasps are in some instances carriers of disease, and it is well known that their stings are poisonous. Among the Hymenoptera and Diptera the female only is active in this respect, the males being harmless. Then in the non-insects the spiders, scorpions and myriapods in some cases are poisonous and carry disease. It is not in all cases that people suffer from the bites of insects; others suffer severely and with ordinary insects. The reason is that the individual is in a bad state of health—the blood is disorganized—because it is a very rare thing for anybody to die from the bite of a poisonous insect, and when they do the bite generally sets up septicæmia or pyæmia (ordinary blood poisoning), due to the faulty condition of the individual. Some people will become very sick and have a very bad sore simply from the scratch of a pin, and others may be mangled fearfully and recover; so that the individual health has a great deal to do with the result.

The bites of insects are acid in character, and of course the remedies used are alkalies. For instance, ammonia put on the wound, potassium iodide and ordinary baking soda mixed with water are very good for some forms of insect bites; and for other kinds sodium sulphite and sodium hyposulphite are very useful. These are particularly useful against some of the ticks and red bugs that burrow into the skin of human beings.

In regard to the butterfly, these, of course, are absolutely harmless; but some of their caterpillars (as I have mentioned in previous lectures) have spines that irritate the flesh, especially when they are roughly handled, when they sting very much like nettles; and in addition to these spines there is in them an active, poisonous fluid which also adds to the irritation when the spines are buried in the skin.

We have a great many insects that are germ carriers; for instance, the common house-fly is one of the greatest carriers of disease. It has been known to eat the eggs or ova of parasitic worms and discharge them, unchanged, in the fæces. The eggs of tapeworms may be so distributed; so it can be readily seen, if flies alight on food, how human beings may be infected. There are certain flies, especially in the Southwest, that sometimes do a great deal of harm to human beings, their young being called the screw-worms. Scientifically they are called *Compsomyia macellaria*. If a person goes to sleep in the open air and should happen to have catarrh (the odor of which attracts flies), they will deposit eggs in the nostrils, and the young maggots will hatch out in the nostrils and crawl up into the frontal sinuses of the skull, and they eat there and do a great deal of damage and cause intense pain, and often death. I remember one case where all the tissues covering the cervical vertebræ had been eaten off; and they even get into the ethmoidal cells. The method of relief for these is to inject chloroform into the nostrils, which will sometimes—or, in fact, almost always—kill them, or it may be even necessary to perform a surgical operation to get these maggots out of the head.

Then there are a great many of these insects, also, that are harmful to domestic animals, and there is one species found in the sheep; it gets into the nostrils and does an immense amount of harm. Further, the tsetse fly in Africa does a great amount of harm to beasts of burden, and it has been one of the causes operative in preventing the opening to civilization and the settling of Africa. Its scientific name is *Glossina morsitans*, and it is "little larger than the common fly. It abounds in some parts of South Africa, but is absent from large districts. Its bite is nearly always fatal to the ox, horse and dog, though harmless to man, as well as to goats, asses, mules and the wild beasts of the region it inhabits."

Some of these lower forms of life do a great amount of damage, as I have said, to animals. There is one species, the ox-warble, a fly that affects the ox; and it is estimated that 50 per cent of the cattle received at the Union Stock Yards at Chicago each year are affected by the ox-warble. The number of cattle received there in 1889 was 1,335,026; the average value of the hide was $3.90; the usual deduction for hides damaged by the ox-warble was one-third. Estimating at less than one-third—say a dollar—the actual loss during six months on hides alone was $667,513. When to this is added the loss for depreciation in value from the deteriorated quality of the beef, the total loss for each infested animal being put at $5 (a very low estimate) indicates a loss from the animals received at the Union Stock Yards in six months of $3,335,765.

There is another fly that is occasionally found in human beings and does harm to them. It is called *Hypoderma lineata*. As a rule, it only affects cattle; but sometimes human beings suffer from it. A girl four years old had been restless and sick for several weeks with a low fever of an intermittent type attended with nervous symptoms. The discharges from the bowels occasionally contained a considerable amount of mucus and some blood. Her appetite, as a rule, was good. Within the last week there developed a tenderness of the abdomen and a slight enlargement over the right lobe of the liver. There appeared on the right side, between the ninth and tenth ribs, a small, red spot which developed into a pustule. On opening the latter a living parasite was found protruding from the skin. This was found to be the maggot or larva of the *Hypoderma lineata*, or a fly that burrows usually in the skins of cattle.

Another case is related by Dr. Hamilton, of Allegheny. "A boy found his health suffering for some months from enlarged glands on the side of his neck and a fœtid ulceration around the back teeth of the lower jaw of the same side. Three months' treatment was of no avail, and the end seemed near. One day a white object which was seen to move was observed at the root of the tongue, and on being carefully removed it proved to be a large grub which, from having frequently seen them, I recognized as a full-grown larva of *Hypoderma lineata*. The case ended fatally. The boy had been on a July picnic in Illinois, where probably the egg in some way had been taken into the mouth."

Sometimes roaches do harm in addition to carrying disease; and the following case is reported: "A nursling six months old—a baby; the abdomen was markedly distended. The child was in great pain and would draw its legs up and cry nervously. After two or three minutes the pain would cease and the child would stop crying and immediately take the breast as though very thirsty. There was about ten minutes between the paroxysms; the pupils were contracted; the pulse very rapid and weak; temperature, 103 to 105 degrees. There was extreme pallor," and so on. A brisk cathartic brought away six cockroaches; so that they can even get into human beings by way of the mouth. It appears that this baby had been taking sweet-medicine (sirup) and these insects were attracted in that way.

One of the oldest forms of disease in human beings was due to the itch mite, as I have mentioned before; but this is not nearly so common at the present day. In these days of comparative personal cleanliness some of the most disgusting insect annoyers of man have dropped out of sight. The lice which in former days were common in all classes of society, from king to peasant, are now comparatively unknown. The itch disease, which carried off many a famous character in history, is equally rare. That it still persists, however, is shown by an occasional case in the medical journals. For example, one is reported in 1892, in the practice of an Indiana physician, of the typical Norway itch, in which the itch mites were present in enormous numbers. A rough estimate showed 7,000,000 eggs and 2,000,000 mites in this one patient. Prof. Girard, of Paris, has reared more than 3,000 specimens of parasites from a single caterpillar; so it must be seen that even insects are not free from parasitic disease.

Insects carry disease germs in various ways, or distribute them in various ways—by transporting the eggs upon their bodies and infecting whatever they alight upon (this is one of the commonest causes of disease and one of the commonest methods of distribution); by inoculating with the disease-producing organism in biting or stinging and also by means of their excreta; and by serving as an intermediate host for the development of the life-cycle of certain disease-producing organisms. This last is the way the mosquito carries the malaria, or produces malaria. They act as an intermediate host for the development of the plasmodium of malaria, or the organism that causes this disease. Many insects have lancet-like mandibles, and they are just as sure in inoculating people with the bacteria or germs as a hypodermic syringe is in running in drugs.

A common carrier of disease is the ordinary bedbug (*Acanthia lectularia*), and this has been known to carry tuberculosis and syphilis. A case is related where a young man died of tuberculosis. Afterward a brother occupying the same bed died of the same disease. His body was covered with bedbug bites. Thirty guinea-pigs were collected and given inoculations from the bugs, and the pigs died soon afterward of tuberculosis.

A Russian observer says relasping fever is distributed by bedbugs also. He found a case of relapsing fever in the place where these bedbugs had their habitat, and injected them into monkeys and produced the disease in the monkeys.

The bites of flies are very annoying and frequently carry disease. In the East one of the commonest diseases is the so-called purulent ophthalmia, which is an inflammation of the eye somewhat like the pink-eye we have here, only a great deal worse; and this disease is undoubtedly carried around by small flies alighting on the eyes of individuals and carrying the germs around and inoculating people in this way. They fly about in many places, especially in the South, in great swarms.

Fleas also carry disease; and undoubtedly fleas are responsible for certain diseases in the lower animals, like mange. They carry the organisms around probably from the lower forms of life that suffer from diseases of this character, and do a great deal of harm, and, as I have also said before, carry the bubonic plague.

The elephantiasis of the East is also transmitted by insects.

An interesting experiment was performed by Moran in regard to the study of bedbugs and the carrying of disease. He took cages of healthy white mice, and by placing the supports of the cages in a vessel containing spirits of turpentine and camphor he prevented inoculation from germs in any other way except by the bite of the bedbugs, by which he intended to have them conveyed. As long as the mice were thus isolated, they remained perfectly healthy. He then introduced into the cage of the healthy mice some bedbugs from the cages of cancerous mice, and after a few months found all the mice were suffering from cancer. Those experiments were thus extremely interesting, because they proved that cancer is a parasitic disease, and also that it can be transmitted by insects.

The itch mite is very readily killed by various proportions of sulphur, either in the form of ointment or by means of baths. It is possible or probable that diseases of this kind may be distributed by other insects; for instance, the ova of the itch mite might be carried from one human being to another by fleas.

One of the latest ideas in regard to malaria is that it is exclusively transmitted and carried about by insects. This doctrine is entirely accepted by many physicians, although there are still some that contend that it is not the sole cause; that while they admit that malaria is carried by mosquitoes, such is not always the case. They say that it can be transmitted through the air and probably by the food and also by drinking water. The supposition is that the *Plasmodium malariæ*, or the cause of malaria, is taken into the body of the mosquito from one human being, then injected into another. It has been proven by observers that only one genus of mosquitoes—the genus Anopheles, as it is called—carries malaria. This seems to be fairly well proven; also that the mosquito that is responsible for yellow fever belongs to another genus—the common genus Culex, which comprises most of the mosquitoes found in this neighborhood. I have seen a number of specimens of Culex in houses; but I never saw a specimen of the genus Anopheles in a house in the city, although doubtless it is found around in the surrounding country.

In regard to methods of getting rid of mosquitoes, the larvæ are aquatic, living in the water; and if all swamps are filled up as far as may be, or if at certain seasons of the year a thin layer of kerosene is placed on the water, when these little fellows come up to the top to breathe, the kerosene will smother them and they may be kept in check in that way. There would be no trouble to get rid of them, if the proper care were taken and the necessary amount of work done. It is impossible, of course, to accomplish the destruction of any of the lower forms of life without labor. It takes time, trouble and patience. They cannot be legislated against and driven out of the country or banished, as some of the ancients thought they could.

House-flies are largely responsible for carrying typhoid fever. The United States government after the Spanish war appointed commissions of physicians to investigate this subject; and they came to the conclusion that the large amount of typhoid fever in the American army during this war was caused almost exclusively by house-flies—that the flies settled on the food of the soldiers in the mess-tents, and the germs of typhoid fever were carried into the alimentary canal of the soldiers in this way and the disease was thus propagated.

It should be a very easy matter to prevent typhoid fever in the camps of soldiers if the life history of the fly and its habits were known to the officers in charge. In the first place, flies should never be permitted to get into the mess-tents where the soldiers are eating. They should be properly screened, and food should be protected in every way, so that the flies could not settle upon it. Entomologists know that diurnal insects—like flies that fly around in the daytime—dislike to go where it is dark; and this knowledge could be used to advantage in preventing typhoid fever. All the drains or the sinks or the privy wells should be properly covered or made dark, and the flies would not go

into such places then, and would not get their feet and probosces covered with fæcal matter and the germs of fever, and would not be able to transmit disease to the mess-tents.

Another method of prevention is found by having a knowledge of the life history of this insect. The common house-fly undergoes its transformations almost exclusively in horse manure, and material of this character should be immediately destroyed, especially in camps; and if the material in which the flies undergo their life changes and life history were prevented or destroyed, they would not be about to carry disease. It is the same way in large cities; the automobile, trolley-car and so on are doing away with horses, and will largely, or almost entirely, do away with horse-flies. The old idea used to be that house-flies and insects of this character, like mosquitoes, were beneficial, because they destroyed fetid or decaying matter; but if we do away with this decaying matter by other means, it is not necessary to have the house-flies and the great annoyance and also the diseases they produce. They produce a great many generations in a year and breed very rapidly, and the female lays quite a number of eggs.

Taking up some of the local insects, let us take one of the common caterpillars found around here [Philadelphia]—the tussock moth. There are a great many people in this city that want to know about protecting the shade trees from this insect; and a knowledge of the life history of the species gives us an absolute clew to this. The full-grown caterpillar is shown, and it is full of hairy tufts, some red, some yellow. The male moth here is a little brown fellow, with pretty, plumose antennæ. You do not often see the males around the city. Occasionally they fly into the room, and when people see them they do not know what they are. Here is a caterpillar dropping down from a tree on a silken thread; and here is a picture of the female; and you will notice that the female is wingless. This fact gives the keynote to the life history—the keynote, rather, to the method of prevention. The female cannot fly and deposits all her eggs in a single mass, after coming out of the chrysalis; and you will notice the eggs are inclosed in a sort of fluffy material which is white; and the egg masses, before they become soiled or dirty through dust and storms, wind and so on, are very white and conspicuous. Another habit in the life history is that of the caterpillar of letting itself down by a silken thread to the ground, and that knowledge is important in its destruction.

How is this species distributed around from tree to tree? The female cannot fly; the male flies, but, of course, has not the power of laying eggs. The method is this—it is due to the great propensity the caterpillar has for crawling. The caterpillar distributes itself around from tree to tree; they let themselves down by a web from the tree on the leaves of which they have been feeding, and then they will crawl off onto another tree, and that is the only method by which the species can be distributed from tree to tree. In regard to the remedies, the method of banding the trees is a very good one. That band must be something that will absolutely prevent the caterpillars from getting up. That is the secret of the whole thing. It is imperative to maintain the integrity of that band. If you put some sticky material on there—whether fly-paper or one of the petroleum products or what-not—it is going to dry up in two or three days; or, if it is put on before it is necessary to be used, then when the critical time comes it has dried out and the caterpillars go up the tree; it is simply useless. If tin gutters are put around the tree and crude petroleum put in or any sticky material, like crude vaseline mixed with tar or any such material used, and replenished at the proper time and not allowed to dry out, then they would be effective and useful; but if this is allowed to dry and the caterpillars allowed to go up, then it is simply a waste of time. If this is effective the caterpillars will spin a cocoon and the females will come out and oviposit within the reach of the hand. The white fluffy masses will be seen on the trees in various places, and each one of them represents from 300 to 500 eggs, and every egg-mass that you take off represents that many caterpillars.

In my judgment, therefore, all that is necessary to rid the trees of this species (the tussock moth) is to maintain the integrity of the band and then at the proper time take off the white egg-masses which are so conspicuous. You cannot help seeing them. They are perfectly patent to the eye of everyone; and if you take a mass and put it in the palm of your hand and roll it around between your fingers, you will find it composed of numerous little eggs, from 300 to 500; and every one of those eggs when it hatches will be a caterpillar, and, as I have told you in previous lectures, the caterpillars have enormous capacity for destruction. They eat, and when they are full grown they weigh some thousands of times more than they do at birth. A great many believe the banding of the trees is absolutely useless. They put a band around the tree and fail to take off the egg-masses, and then these hatch out, and by that time the band has dried out and the little caterpillars go right over it and go up the trees and begin destroying the leaves again. Then, of course, another thing is of interest; if a tree is in front of one house, and properly cared for, and the next neighbor does not do anything, that makes trouble sometimes; but even that would not do any harm, if this band were maintained, because, as I say, the only way that these insects can get up the tree again is by means of the caterpillar, because the female is wingless and cannot fly.

Another local injurious species that is not common in Philadelphia, but around the surrounding country is not uncommon, is the so-called bag-worm (*Thyridopteryx ephemeræformis*); and if these cocoons that are attached to the twigs are picked off in winter, it is an excellent way of getting rid of the species, because in this case also the females are wingless, and the eggs of the female are represented on the screen. This species lives through the winter in the egg state in this way; each one of those cocoons will have, may be, several hundred eggs, and if you pick off the masses and burn them, of course it destroys what will be that many caterpillars the following summer.

Sometimes the egg-masses of the tussock moth are simply scraped onto the ground by wire brushes. The eggs are extremely hard; in fact, they are so hard that when you drop them into a flame they will explode and make a report, because the heat develops steam in them and they crack with quite a little explosion. If they are simply brushed onto the ground and allowed to lie there, it does not do them any harm. When the proper time comes they hatch out and crawl up the tree, so then the egg-masses should be picked off and then burned; or if you scrape them onto the ground, you ought to put a piece of canvas or some manila paper on the ground, and then after being scraped down they should be collected and burned.

Another common pest is one of the house-moths. The caterpillar that does the harm is shown here, and there the eggs, and above the perfect insect (*Tinea pellionella*). These insects do not like light; and if garments of various kinds are exposed to the light and properly shaken at certain seasons of the year, the insect could be readily kept in check; and then the materials that they destroy can be protected by keeping them in tight cases. Insects are air-breathing, and the receptacles in which clothing is kept should be air-tight; and if plenty of camphor is kept in there, they would not live; but if they can get plenty of air to breathe, the contrary is the case, and they flourish.

The species of house-moth (*Tinecla biselliella*) is found further south; it lives upon feathers and woolens, and will even eat skins of various kinds—the skin (rabbit's and other) handles of combs and brushes, also used for paper-cutters, etc.

They can be very readily destroyed in carpet by the use of naphthalene used thus: Take the balls of naphthalene and throw them on the floor where the carpet is infected with moths, and just grind them into the carpet with the foot; mash them right in. All of these materials have to be used plentifully, and one of the troubles is that enough is not used, as a rule. The naphthalene could also be melted. It melts at a very low temperature, and you should be a little careful not to allow it to catch fire; and it can be poured into the carpet and then it instantly sets and will destroy all insect life in the carpet. That is a very excellent method for killing the buffalo-beetle, called buffalo-moth, also infesting carpets. Bedbugs are very bad, especially in the South, and they have more trouble getting rid of them; and I do not know that that method has been used—entirely filling up all the cracks where the insects are seen with this melted naphthalene; it would no doubt be very effective.

This is the fly (*Peophila casei*) that causes the little worms in cheese. The female flies around and deposits its eggs in the cheese, and then they hatch out into a maggot such as we see here, and this is the pupa case; and this is inside of it, or the chrysalis inside the pupa. This insect does not do any harm, particularly; but there are a great many people who do not care about eating the little worms in the cheese.

I mentioned the fact of fleas carrying the bubonic plague and other diseases, and especially carrying diseases from one domestic animal to another; and undoubtedly it is capable of carrying disease from man to man, just the same as the bedbug is known to carry disease from man to man. Some people suffer severely for some reason from fleas; while there are others they won't stay on and do not seem to like; but if they do get to the right person, they seem to stick to him with a great deal of pertinacity.

I noticed in a daily paper recently that there was a house in Baltimore, the timbers whereof were very badly infested with the white ants, or *Termes flavipes*. I do not know what was done, but the damage was very serious; and they even thought of tearing down a part of the house. I show these insects on this slide. They hollow out timbers of various kinds; and timber that is apparently, and in fact is, perfectly sound, they will get into and will hollow out and leave a shell on the outside so that they cannot be seen; and sometimes furniture is damaged in this way, and a chair will look apparently all right, but if you sit down on it the legs will go to pieces. The same way with the joists in houses and the beams in bridges. Before iron bridges were extensively used railway accidents were caused in this way: These insects would hollow out beams and make them a mere shell, and everything would go to pieces all of a sudden. The United States Government Entomologist was consulted with regard to this damage in Baltimore, and he suggested spraying with benzine and bisulphide of carbon, either of which would destroy this insect. I imagine that melted tar camphor would also be very effective; if the excavations were filled with this material, the insect would be destroyed.

The newly hatched larva of the so-called white ant, or *Termes flavipes*, is interesting. It really does not belong to the same order of insects as the ants, but they look very much like ants. The soldiers of different species of Termes or white ants have powerful jaws for biting their food and also for use in their battles. They bite very savagely.

The so-called buffalo-beetle or buffalo-moth that is only found in carpets is a little black beetle ¼ inch long, and has white markings on the back. The young are hairy-looking affairs, and do considerable damage to carpets. The damage looks very much the same as that by the common house-moth; but if the carpets are examined, the larvæ of this species can often be found, and without any trouble, if searched for. The same remedies apply for this as for the house-moth: Melted naphthalene poured into the carpets or ground in with the foot; benzine or gasoline is excellent; but if the last two be used, great care should be taken to see that there is no fire about, because when the vapor of benzine or gasoline is mixed with water it becomes very explosive and dangerous.

The pavement ant, as it is called, is a little black ant, very common. Sometimes they are annoying and throw up a lot of gravel and dirt in yards; people often want to know how to destroy them. If the excavations they make be filled with bisulphide of carbon, these insects are smothered to death. It should be just poured into the little cracks between the bricks, or into the earth where this species is found. Hot water is also effective.

The same thing applies to the red ant found around houses. If their nests can be found and the places where they abide filled in with plaster of Paris, that also destroys them; but if that cannot be done, the next best thing is bisulphide of carbon. These ants are often found around washboards, in closets and breadbaskets, and various places of a similar character.

Crickets are sometimes very destructive to clothing. This is particularly true upon the seashore; the coast-guards complain bitterly of having their clothes eaten up by this insect. I do not know of any good way of preventing this except by keeping the clothing in receptacles to which the insects cannot have access—where they cannot get in. But if the clothing is kept where the insects can get at it, perhaps the best thing to keep them out is a plentiful supply of tar camphor or naphthalene.

The common cockroach is often quite annoying, and a good plan to rid houses of this species is to use a plentiful supply of borax around on the floor; but perhaps the best remedy of all is to fill all places where they can hide and congregate with plaster of Paris. Just go around the room—for instance, the kitchen—and take soft plaster of Paris and fill in all the cracks and crannies and destroy them in that way. If all such places are filled up, the roaches have no abiding-places.

AN INDICTMENT OF THE RAT.

UNTIL recently it has been impossible to convict the rat of any graver offense than larceny, damage to articles of food which he could not carry away or completely devour on the spot, and the construction of rapid transit tunnels without any charter, says The New York Tribune. These offenses have been aggravating in the extreme, but they never led to any concerted movement for his extinction. There has been no co-operation among those who sought to capture or destroy him. But it is now known that he is more than a mere nuisance. As a disseminator of disease he works much more serious injuries to human society than those hitherto charged to his account, and there are signs that this discovery may lead to a systematic crusade against the offender.

A Japanese bacteriologist, Dr. Nashuda, who was visiting in Chicago a few days ago, declares that the Mikado's government is likely to propose to other nations a league against this rodent. The story is not improbable. There have been international congresses to discuss cholera, bubonic plague, tuberculosis, leprosy and other infectious maladies. Why should not all civilized countries unite to suppress such a well recognized source of danger to health as rats?

The malady with which these animals are most closely associated in the public mind is the bubonic plague. Thousands of them—perhaps it would be safe to say hundreds of thousands of them—are carried off by this disease in Oriental countries each year. Indeed, it is not uncommon for rats to die from that cause in a house before any human subjects are attacked by it. Rats are such ramblers, moreover, that it is possible for them to infect a whole neighborhood before the fact is discovered; and as they often die in inaccessible places their bodies may remain hidden but active sources of infection for days and weeks. The germs of the bubonic plague are transmitted to the soil and air in this manner, and thus find easy entrance to the lungs, food and skin scratches of human beings.

Only a few weeks ago a man in Cardiff, Wales, was employed to clear a store of dead rats, a kind of rat epidemic having prevailed there. A week or so later the man himself succumbed to a mysterious attack of illness, which eventually proved to be the genuine bubonic plague. When such an incident can occur in a healthy port like Cardiff, it is easy to understand how the same agency can work far greater mischief in the filthy, crowded tenements of a place like Bombay or Hong-Kong.

But there is reason to suspect the rat of complicity with the dissemination of other diseases also. The singular preference which some disorders show for one class of animals and their comparative indifference to another is a remarkable phenomenon. Thus, cows are peculiarly susceptible to tuberculosis; but that disease never affects a rabbit unless the latter is artificially inoculated. Cats rarely acquire diphtheria in a natural manner, although they will develop the proper symptoms if diphtheria germs are introduced into their veins, and rats are practically immune against the disease. An injection of toxin a hundred times as big as is necessary to sicken a cat will not affect a rat at all. On the other hand, the latter is almost the only known creature, aside from man, which acquires the bubonic plague. Cats and dogs occasionally, but rarely, take it. Again, few animals besides the hog ever suffer from trichinæ, and among these few are rats and mice. In fact, rats are suspected of being one of the means whereby hogs are infected with the parasites. Trichinæ get into man or an animal only through the blood. Rats and hogs are both flesh eaters, and if a healthy hog had a chance to eat a dead rat in whose body a lot of trichinæ were curled up it would do so without hesitation and would suffer the consequences. So far as is known, the only way in which hogs can become infected is to eat the flesh of a trichiniferous rat, mouse, cat or puppy. Full grown dogs never suffer from this trouble.

But rats and mice can transmit the germs of other diseases than those of which they are themselves the victims. It is a well established fact that common flies carry typhoid and other baleful bacteria on their feet from masses of infected matter to perfectly clean articles of food which are carelessly exposed. Now, it is not so clearly proved that rats and mice act in the same manner, although it is probable that they do to some extent. Dr. W. H. Park mentions a case in point.

A culture of a certain bacillus that was under examination had been made in a bacteriological laboratory. A mouse got access to the tube, ate some of the gelatinous mass in which the colony was raised, neglected to use napkin or finger bowl, went off to some other culture tubes in which there was uncontaminated jelly and sampled it. Soon afterward this jelly too developed the same kind of microbes as had been cultivated in the first mentioned tube.

The incident illustrates the ease with which bacteria can be carried to meat, bread or other articles of food which are not securely guarded. The housekeeper who discovers the marks of a rat's or a mouse's teeth upon cheese, pastry, vegetables or other provisions that

have been carelessly stored is not likely to consider in what other quarter the mischievous rodent may have been picnicking previously. To be sure, flies will visit offensive and infected matter of various kinds that a rat or mouse would hardly touch. On the other hand, the latter are liable to pick up disease germs in the soil and elsewhere and transport them in their fur. While, therefore, it is difficult to make out so clear a case as would lead to prompt conviction in a court of law, there are serious possibilities of danger from this source which have probably been overlooked.

A year or two ago it was announced that a microbe had been discovered by one Danysz which was fatal to rats. Immediately the hope was excited that this organism could be turned to advantage. If a number of rats were inoculated with microbes of this variety and were to die, and if their surviving companions were to eat their dead bodies, in accordance with rat custom, a blessed epidemic might ensue. Within a few weeks the first practical experiments in this direction have been reported. Success apparently did not attend these early efforts, which were confined to the sewer rats in Athens. Two difficulties were encountered. The disease germs are not sufficiently virulent to act satisfactorily, and the bodies of those rats which die in consequence of inoculation are not eaten by their companions. For the present, therefore, it is doubtful whether this new expedient will be of any service; and even in the matter of direct poisoning there is much yet to be learned. If Japan initiates a grand international movement for the suppression of rats, therefore, it will be wise to improve, if possible, upon existing methods of warfare.

NEW PROCESS OF PELVIMETRY AND LONG DISTANCE RADIOGRAPHY.

IT will be readily understood how important it would be to surgeons if they had at their disposal a practical and reliable process that would enable them to determine with precision the exact configuration and real dimensions of the pelvis of a pregnant woman. The obtaining of such data, in fact, would be infinitely valuable, since it would result in permitting the practitioner to take in advance every precaution necessary. So, for a long time, specialists among surgeons have been endeavoring to devise apparatus that would permit of attaining this object. Unfortunately, of the manifold instruments proposed, none up to the present has furnished results that are truly satisfactory, and the various pelvimeters, whatever be their combination, never give anything but very uncertain information, in all cases inferior to that obtained by a careful digital and manual examination. Such an examination is, however, attended with errors that may reach a centimeter and a half, or even double that figure, when it is effected by means of measuring instruments.

With the discovery of radiography, it was thought that a truly convenient process of observation was to be placed at the disposal of the physician; but the experiments tried did not succeed. Nevertheless, it was in the application of radiography, as Dr. Henri Varnier has just experimentally demonstrated, that the solution of the question resided. But in order to solve the latter successfully it became necessary to devise new means very different from those commonly employed.

Speaking in a general way, when it is a question of obtaining a radiograph, the operator arranges the bulb that produces the X-rays at quite a short distance from the object to be radiographed and usually varying from 40 to 60 centimeters (15.7 to 23.6 inches). The result of such practice is that since the radiographic negative registers only the projected shadows of the object, the image obtained is somewhat larger than the original, at least for all the parts of the latter not in direct contact with the sensitized plate.

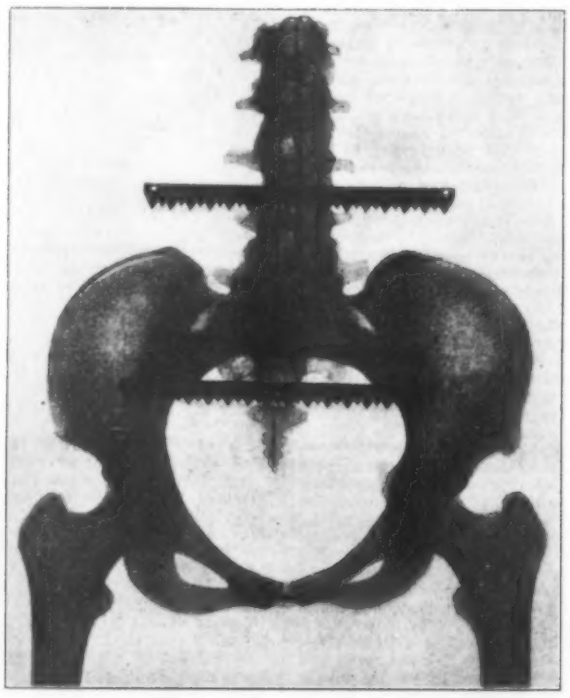


FIG. 1.—RADIOGRAPH OF A DRY PELVIS, TAKEN AT A DISTANCE OF 33 FEET FROM THE BULB.

In order to surmount this serious difficulty it occurred to Dr. Varnier to remove his source of Roentgen radiations to a sufficient distance to permit them practically to behave as would sensibly parallel radiations emanating from infinity. In order to obtain such a result, there is no need, however, of placing the bulb at a great distance. Experiment has shown Dr. Varnier, contrary to usual belief, that the sources of active radiations may be placed at a considerable distance and ordinary bi-anodic bulbs employed.

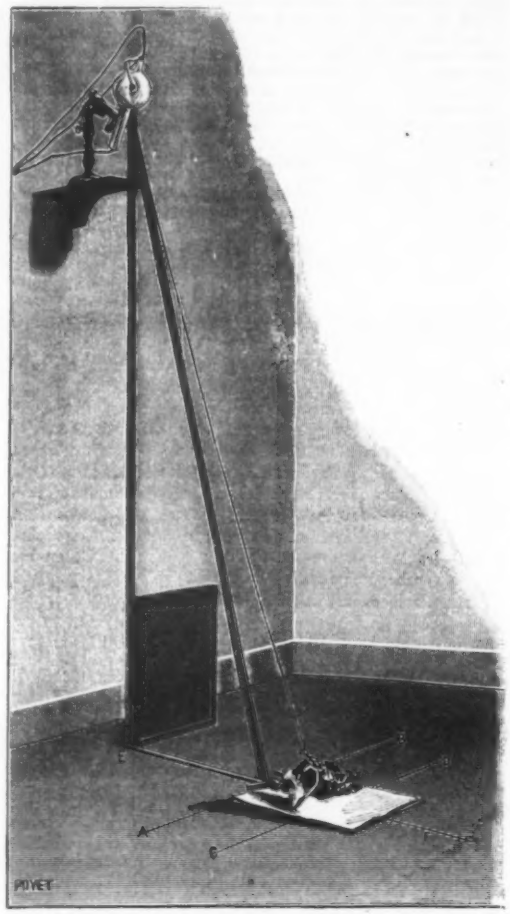


FIG. 2.—VARNIER'S ARRANGEMENT FOR RADIOGRAPHY.

With a coil giving a 25 centimeter (9.8 inch) spark and provided with a Ducretet and Lejune vibrator, he has been able, in an exposure of ten minutes and with a current of 10 amperes at 26 volts, to obtain the outlines of a dry pelvis upon a photographic plate placed at a distance of 25 meters (82 feet) from the bulb, and, in an exposure of twenty minutes, the same outlines upon a plate at 30 meters (98 feet) distance. But for ordinary needs it is not necessary to have recourse to such distances, which would have the serious inconvenience of necessitating more prolonged exposures than it is desired to ask of a patient.

In practice a distance of 5 meters (16.4 feet) gives entire satisfaction. At such a distance, in fact, the usual instruments of measurement no longer permit of ascertaining any difference between the dimensions exhibited by the object and the radiotype.

For ordinary exigencies a distance of 2.5 meters (8.2 feet) is sufficient, as shown in the following measurements made by Dr. Varnier of a dry pelvis.

The error found in such a case is, as may be seen, of the same nature and never exceeds 5 millimeters (0.196 inch); that is to say, it is practically negligible.

As for the modus operandi employed by Dr. Varnier in order to obtain such results—that is extremely simple. The Crookes tube is placed at 2.5 meters (8.2 feet) from the plate with its cathode perpendicular to the prolonged axis of the upper brim of a normal pelvis taken as a point of observation.

The following table was compiled by Dr. Varnier from experiments and measurements with a dry pelvis, and in it will be found the difference between the dimensions of the pelvis itself and the radiograph:

Measurements Made.	Dry Pelvis.		Radiotype.		Difference.	
	mm.	inches.	mm.	inches.	mm.	inches.
Maximum transverse diameter	122 =	4.803	125 =	4.921	+3 =	+0.118
Antero-posterior diameter (The only measure up to the present)	114 =	4.488	117 =	4.606	+3 =	+0.118
Left oblique diameter	118 =	4.645	121 =	4.763	+3 =	+0.118
Transverse bi-ischiatic, (The part furthest from the plate)	100 =	4.055	108 =	4.251	+5 =	+0.196
Width of the first piece of the coccyx	32 =	1.259	33 =	1.299	+1 =	+0.040
Distance of the anterior and posterior iliac bones	235 =	9.281	235 =	9.251	+0 =	+ .0
Transverse diameter of the greater pelvis	250 =	9.842	250 =	9.842	+0 =	+ .0

Along the line *A B* (Fig. 2), taken as a base, he arranges in his frame a 40 x 50 centimeter (15.74 x 19.68 inch) sensitized plate. The dry pelvis is then placed in pronation (i.e., with the front downward) with the line of crests resting upon *C D* and its anterior-posterior diameter in line with *E F*.

In order to operate upon a living person, it suffices to replace the dry pelvis by the subject to be examined, who must lie so that the pelvis will assume the same position. By using the data given the measurements may be accurately obtained.

The method, as may be seen, is as easy as it is ingenious, to say nothing of the fact that it is attended with no inconvenience to the person upon whom it is employed. And this is not an unimportant circumstance, since it is quite generally known that the too close proximity of the X-ray bulb may cause serious skin disorders in some subjects with a particularly sensitive skin.

There is every reason to think that the new process proposed by Dr. Varnier for long distance radiography will soon be extensively used for this greatest of maladies which it has been found to benefit.

The data given in the above table are those used in the special radiographic department of the Baudelocque clinic, which department was founded four years ago for obstetrical purposes by Prof. Pinard and Dr. Varnier.

We are indebted to La Nature for the description and illustrations.

STUDIES IN VISUAL SENSATION.*

THE object of these studies is to frame if possible a scale of visual sensation analogous to, and in correlation with, a scale of physical luminosity. The method is the employment of rotating disks.

If a disk be divided into eleven concentric areas of equal width, of which the inner is all white and the outer all black, while the intervening areas have sectors giving a series of 10 per cent increments of white, this gives on rotation a series of gray rings between the black and white; but they are of very unequal values for sensation. While the step from black to the darkest gray involves a large stride in sensation, seemingly almost half-way toward the white, that from white to the lightest gray is no great amount.

A contrast effect is very noticeable. Each gray annulus, especially in the darker rings, is differentiated in sensation into a darker moiety where it adjoins a lighter ring, with a lighter moiety where it adjoins a darker ring. But although contrast introduces a factor which somewhat distracts the judgment, the disturbance is not sufficient to invalidate the conclusion that equal, or approximately equal, increments of stimulus produce increments of brightness which differ widely in value.

By the use of slit disks on Maxwell's method the proportions of white stimulus may be so adjusted as to give, say, three rings intervening between white and black which do give approximately equal sensation steps. It is somewhat difficult, however, to estimate their value, and contrast again introduces a disturbing element. We obtain only a first approximation to a scale of sensation. Taking the black employed (admittedly only a very dark gray and not an absolute black) as a zero, and calling the value of the white 100 per cent, both for sensation and stimulus, we have, on the arbitrary scale thus formed, the following percentages:

	Sensation.		Stimulus.	
	Increment.	Sum.	Increment.	Sum.
Black ring...	0	0	0	0
Dark gray...	25	25	6.5	6.5
Mid gray....	25	50	13.5	20
Light gray...	25	75	27	47
White ring..	25	100	53	100

Here the equal increments of sensation are correlated with increments of stimulus very nearly in geometrical progression.

By interpolation a smoothed curve can be drawn through the observed mid-point of 20 per cent stimulus and translated on to a disk. But this does not give a smooth increase of sensation from black to white through intervening grays. The value of the mid-point is too high.

Experiments with smoothed curves show that a mid-

* Abstract of the Croonian Lecture delivered at the Royal Society on March 21 by Principal C. Lloyd Morgan, F.R.S.

point of 12 per cent gives an approximately even passage from black into white.

The discrepancy between the ring-grading and the smooth shading is shown to be probably due to the contrast effects before mentioned, of which a rough quantitative estimate can be given.

The curve through 12 per cent mid-point, with equal increments of sensation correlated with increments of sensation in geometrical progression, is accepted as affording an arbitrary and empirical scale for increase of brightness due to increase in physical luminosity.

Colors are dealt with and even shading is obtained from black into blue, and into red, orange, etc.; white into similar colors, and one color into another—for example, red into blue through intervening shades of purple.

The luminosity of these colors is determined in terms of the arbitrary scale on Sir Wm. Abney's method; and the results, as deduced from the empirical curve, are compared with those directly observed by the method of shading in rotating disks.

For comparison, the results are given in terms of the mid-points of curves analogous to that for the shading of black into white:

Mid-Point Percentages.

	Deduced from Luminosity. Per Cent.	Observed by Method of Shading. Per Cent.
Yellow on black..	13.8	13.5
Orange on black..	18.6	18.0
Light blue on black	19.7	19.0
Red on black.....	23.6	23.0
Full blue on black	29.5	28.0
White on full blue.	24.7	25.0
White on red.....	30.6	30.0
Orange on full blue	35.4	36.0
Yellow on light blue	39.1	40.0
Red on full blue..	43.0	44.0

If these results be accepted as giving a sufficiently close agreement, it follows, first, that for color shading the percentages of stimulus required are dependent on the luminosity of the colors employed; and, secondly, that all the data obtained by the methods of shading can be plotted on a single curve which exhibits the relation of stimulus to sensation in visual impressions.

If we assumed that the black on the arbitrary scale has a value of 1.87474, and if this amount be added to the stimuli throughout the scale, so that the white becomes 101.87474, the mid-point 13.87474, and so on, the scale becomes, so far as stimulus is concerned, an absolute scale. And on this absolute scale of stimulus, the sensations, plus some undetermined constant, form an arithmetical series, while the stimuli which are in relation to them form a geometrical series. In other words, the addition of this constant to the summed increments of stimulus at any stage of the scale causes these summed increments to fall into line as the terms of a geometrical progression. The stimulus value of the mid-point on the absolute scale is the geometrical mean between the values of the extremes on the same scale. *On this assumption*, therefore, and *between these limits*, Weber's Law and Fechner's expression of it hold good.

Its validity beyond these limits is questionable. Dr. Waller has shown good reasons for believing that near the threshold of sensation the completed curve shows change of sign, and becomes sigmoidal. Apart from the evidence he adduces, some such assumption seems to be well nigh necessary if we are to attempt to give a complete curve, which, near the threshold of sensation, does not land us in the maze of difficulties arising from the asymptotic character of a wholly logarithmic curve.

EXPERIMENTS WITH CÆSIUM COMPOUNDS.

IN a recent paper read before the Académie des Sciences, M. Chabrié describes a number of experiments in which he obtains compounds of the metal cæsium. This metal, which was one of the first to be discovered by spectrum analysis (1861), has been comparatively little studied. It is quite rare, and its atomic weight is high, and its monovalence, which makes it enter in considerable proportions into its combinations, has rendered its study difficult. The author obtains cæsium from the mineral pollux, which, as Pisani has shown, contains it in the largest proportion; he has prepared a number of compounds with the intention of filling up the gaps which exist in the series at present.

Bromide of Cæsium.—Different bromides have been mentioned in various works, among others a tribromide, a pentabromide, prepared by Wells and others, two chloro-bromides, etc. The preparation of the monobromide has been realized by different authors, but none of these appear to have given an analysis of the product obtained. The experimenter has succeeded in preparing the bromide in a pure state by the following process. Two solutions are prepared, one containing 16.17 parts of sulphate of cæsium previously calcined, and the other 14.36 parts of hydrated bromide of barium; the solutions are mixed and the liquid filtered from the precipitate and evaporated to dryness. The residue is calcined and then dissolved in water. This solution is then subjected to a fractional crystallization. The top portion of the crystalline mass must be taken, this being formed of smaller and less well-defined crystals. These are dried upon porous plates and then in vacuo over sulphuric acid. Analysis gives them the formula CsBr. These crystals have no effect upon polarized light.

Iodide of Cæsium.—The iodide has been prepared by Beketoff by double decomposition between sulphate of cæsium and iodide of barium, but he does not give the analysis necessary to fix its composition. The author obtains it by adding to a neutral solution of sulphate of cæsium a solution of iodide of barium until the precipitate ceases. The filtered liquid is concentrated and evaporated in vacuo. In this way cubical crystals are obtained which are very white and quite sharp in form; analysis gives them the formula CsI.

Fluoride of Cæsium.—The only compounds of the metal containing fluorine which are known at present are the fluosilicate, prepared by Preis, the fluophosphate and the fluodithionate, prepared by Weiland and Alfa. The author succeeds in preparing the fluoride by the following process: A solution of pure carbonate of cæsium is evaporated to dryness at 150 deg. C., and the residue then dissolved in pure hydrofluoric acid in a platinum capsule with a slight excess of acid. This solution is concentrated by boiling, and before it becomes saturated it is placed in a vacuum over sulphuric acid, then with quicklime. In this way long crystalline needles were obtained, these being the fluorhydrate of the fluoride of cæsium, CsFl, HFl, which is distinctly acid in character. If this compound is calcined at a bright red heat it decomposes, melts and partly volatilizes, leaving a residue whose solution is strongly alkaline. If the calcination is stopped somewhat before the fusing point, and especially if a little fluoride of ammonia is added before reaching a low redness, the remaining compound is found to consist of the fluoride of cæsium, which crystallizes in the cubic system. Analysis gives it the formula CsFl.

Chromate of Cæsium.—This salt has been prepared by the author in clear yellow needles an inch or more in length. These are formed by treating a solution of neutral chromate of silver by chloride of cæsium; 7.93 parts of the former and 7 of the latter are taken, and the boiling solutions mixed and agitated. After filtering and concentrating, the crystals are seen to form. These are collected and dried; they are not altered at 100 deg. C. The formula for the chromate is found to be Cs_2CrO_4. The bichromate has also been obtained in small crystals of a brilliant red, by dissolving, in a neutral solution of the chromate, 0.26 per cent of its weight of chromic anhydride. By concentrating the solution the crystals are obtained; these are very stable and anhydrous, having the formula $Cs_2Cr_2O_7$. The author is at present examining the properties of these compounds.

ARRIVAL OF THE 7-TON DATE PALM, SHOWING BOX AND METHOD OF SUSPENSION.

MOVING LARGE PALMS IN CALIFORNIA.

By CHARLES FREDERICK HOLDER.

TREE-MOVING is more or less an exact science, and some of the most remarkable examples have been seen recently in Pasadena, Southern California. The town, of about twelve thousand inhabitants, is a famous tourist center, thronged in winter with visitors from all over the world, who take possession and revel in the delights of an almost perfect semi-tropical climate. Owing to this winter contingent, Pasadena has grown in a remarkable way, and it is said with truth that it has more wealthy residents for its size than any city in the country. The secret of this lies in the fact that many visitors, becoming infatuated with the beauties of the place and the climate, have bought homes here, and one of the finest avenues in the State is almost entirely lined with beautiful residences of people who have drifted here on account of the climate and have decided to remain.

Pasadena stands at the head of the San Gabriel Valley, on the edge of the Arroyo Seco, reaching virtually from the lofty Sierra Madres south for six miles to the Mission Hills. The Sierras form a wall to the north, giving the locality protection from the wind, while the ocean, thirty miles distant, provides cool breezes even in summer, affording a condition of things climatic which the writer believes, after a residence here of sixteen years, justifies the most enthusiastic encomiums. A little over two decades ago Pasadena was a barley field, the only trees being native wild oaks; to-day it is a veritable garden of palms, from ten to fifty feet in height; date, fan and every variety of palm, the lime, orange, banana, and almost every tropical and semi-tropical fruit or flower. The rapidity with which the town has taken on the appearance of age is remarkable, and it is not saying too much to state that a place can be given the appearance of fifty years' growth in ten.

The phenomenal changes in the appearance of the town are traceable in many instances to the work of the tree mover, illustrated in the accompanying photograph. It is possible to purchase a vacant lot, erect a house and in a few days surround it with palms and other trees, which give the place the appearance of having been under cultivation many years. This is due to the ease with which experts move the largest trees in Pasadena. A would-be resident builds a house, then purchases large trees from the outlying country, and presto! the place at once assumes the appearance of long growth and mature age. During the present winter this was illustrated at the winter residence of Mr. Frank T. Holder, of Yonkers, N. Y. Mr. Holder purchased an attractive house of the mission style of architecture, on Orange Grove Avenue, Pasadena. There were no large trees on the place, so it was decided to move two large palms which were available. The largest had been planted in 1880 by Mr. James Campbell—a magnificent specimen of date palm (*Phœnix canarensis*) which stood about thirty feet high, with a spread of nearly thirty-five feet. The plan was to move the tree from St. John's Avenue to Orange Grove Avenue, a distance of several blocks, and a local florist not only took the contract but guaranteed that the palm would show no effects of the shock, lose none of its leaves—in a word, suffer in no way except possibly a retarding of its growth for several months. That the guarantee could be made was evident from the fact that the florist had moved thirteen large palms before this winter without injuring them. The work required about five days and the labor of five men and four horses most of the time, and was successfully accomplished at a price less than fifty dollars per tree.

A square trench was first made about the tree to a depth of about six feet, when it was found that the roots grew out in a lateral direction. The object was to leave a large "ball" about the palm, which in this case was a square block about five feet on a side and six feet high. This accomplished, and the sides cut perfectly even, the four sides of a heavy box were fitted against it, and, by iron rods and screws, clamped into shape, so that the root was in a compact square shape and boxed, weighing about seven or eight tons. The tree was now lifted by the aid of four jackscrews, the numerous bottom roots cut and a wooden bottom to the box clamped on. The tree was then suspended in the hole, and was gradually lifted up by the manipulation of jackscrews until it was at the surface, when the truck was hauled upon the lot, a curious affair, with two wheels in front and four behind. In other words, behind there were two two-wheeled trucks, while heavy scantlings extended lengthwise over them. This was hauled to the tree, which was gradually jacked up, and finally attached by heavy chains to the truck and the palm was suspended and just clearing the ground. Rails were now laid, and by means of a pair of horses and block and tackle the whole affair was run off the lot over the curbing to the street. Two horses were now harnessed to the pole, and the cavalcade moved slowly up the street, arriving in less than an hour at the destination—shown in the photograph. Here the same operation, only reversed, was repeated; the truck with the tree was run across the curb by the block and tackle and slowly hauled over the excavation, which was about six feet in depth, well supplied with rich dressing.

This was the most difficult part of the work, yet two men manipulated the jack screws so cleverly that the great palm gradually sank out of sight. Once in perfectly horizontal position, the wooden sides of the box were unscrewed and the tree and its earth-surrounded root stood without a crack.

Equal parts of earth and dressing were now thrown in and carefully tamped down, and finally the ground was soaked and retamped. When the débris was cleared away, the palm stood as erect and perfect

as it had in its original growing place, showing no evidence of shock of removal. A few days later another palm, estimated at five tons weight, was placed near the same house, adding materially to the appearance and value of the property, and certainly to its age, so far as general effect was concerned.

The ordinary fan palm, so common in Southern California, is so tenacious of life that comparatively little care is needed; in fact, a block and tackle has been attached to one and the trunk literally torn from the earth and replanted without injury. One of the most notable examples of this tree moving was seen in Los Angeles several years ago when a fine palm (*Washingtonia*) estimated at fifty feet in height, was taken from a ranch and hauled through the city to the Southern Pacific depot, where it was replanted directly in front of the entrance, where it still stands, a striking illustration of what can be accomplished by the skilled tree mover. A palm of very large size and goodly proportions was hauled from Los Angeles to the town of Alhambra, eleven miles distant, without injury; and there seems to be no limit to the vigor of these trees, which add so materially to the attractiveness of the country.

THE HERBARIUM CASES AT THE FIELD COLUMBIAN MUSEUM, CHICAGO.

THE Curator of the Department of Botany in the prosecution of his notable work in the herbarium, extensions to which have been necessary during the year, says:

"The steady influx of specimens rendered an increase of space for cases an urgent necessity early in the year, and an extension 30 x 18 feet was planned and built over the east gallery adjoining the Curator's office. This was finished and ready for occupancy early in May. It has three large north windows, and

HERBARIUM CASE, FIELD COLUMBIAN MUSEUM.

accommodates eighteen herbarium cases of the new construction described below, twelve of the old Bebbian cases, two special research tables and a long distributing table as well. The herbarium now has a total of sixty-eight cases, containing in all 1,744 pigeon-holes. Through this enlargement the storage room was freed of much accumulated material, and its space became available for systematic arrangement. This room now contains, besides the mounting table and accessories, a continuous rack bearing sixteen large tin cases of fifteen pigeon-holes each for the poisoning and storage of duplicates preparatory to their distribution, and eighteen similar cases of trays for the storage of the larger fruits and seeds pertaining to the herbarium sheets. All of the cases in the herbarium from its inception have been constructed upon a principle that renders them as nearly air-tight as possible. The interiors are so arranged that a two-inch space exists between the face of the pigeon-holes and the door, and a like space between the perpendicular stops at their back and the back of the case itself. By this means internal circulation is complete, and as much insectifuge as may be deemed advisable can be thrown through between the stops, where it is retained free of the pigeon-holes at the bottom of the case. Here also all plant detritus automatically collects with the withdrawal and insertion of the plant fascicles as they are used. A half round groove, one-quarter of an inch deep, is run completely around the inner face of the door frame, which fits over a like bead on the inner stop; this renders the cases insect and dust proof. The doors are glass paneled, affording a comprehensive view of the contents of each case, thus avoiding the necessity of referring to an index when locating the orders. In the earlier cases two semi-circular spaces were cut from the face edge of the shelves, in order that the fascicles of plants might be readily grasped for withdrawal by one or both hands. This method is, however, open to strong objection, as the frequent grasping of the bundles breaks the plants contained and soils the genus covers as well. In order to avoid this the following scheme, converting each pigeon-hole into a drawer, has been adopted. Sheets of heavy straw-board, one inch longer than the depth of the pigeon-holes and slightly narrower, were procured, and a strip of black muslin two inches wide firmly glued on the face of one end. The reverse side was then scored half through one inch from the edge and parallel to it, and the end bent downward, thus forming a flap dropping over the face edge of the pigeon-hole. These 'slides' are placed under the fascicles in each pigeon-hole, and when pulled forward by the drop, bring the contents forward for inspection. The drops of the slides may be left blank, or order, section, or genus labels may be pasted upon them as desired. The facility with which the contents of the pigeon-holes are consulted through the use of these slides has been a daily source of comfort and a great saving of time and wear. These cases have, however, the great fault of all herbarium cases—the nuisance of swinging doors. To overcome this the Curator devised the following form, arranged internally like those described above, but with the door so constructed that it can be pushed back between the case and its neighbor, thus leaving the contents entirely free from obstruction. Twelve of such cases have been built and installed in the new room and have proven perfectly practical and satisfactory. They are nearly seven feet high, by three feet four inches wide, and contain forty-five five-inch pigeon-holes and three sliding shelves each. They are placed back to back in six separable pairs (*A*, *A*, *B*, *B*), thus affording ample accommodation for the doors when pushed back out of the way. When set in place the pairs are held rigidly together by the tracks (*c*, *c*, *e*, *e*) in which the doors slide; the cleats (*i*, *i*, *i*, *i*) being fixed in place by strong screws before the metal guide-strip (*c*, *c*, *e*, *e*) is attached. The door is hinged at *g*, *g* to the wing piece (*E*, *E*), which slides forth and back with it on the track, and is supported at all points in its movement by the silent pivoted caster (*h*). This caster is mounted in a hardwood block which serves the purpose of a check to the door when pushed back, and a foot press when locking it after closing. The operation of the doors requires no more effort than that expended with the ordinary kind; it is simply opened until checked by meeting the face of the wing, then thrust away with a push. In closing it is pulled forward by the key of the lock until stopped by the rolling pins (*d*, *d*), then swung shut. Although the door is entirely separate from the case itself, yet by the bead and groove construction mentioned above, these cases are perfectly tight when closed. When arranged side by side in the herbarium, they occupy but two inches more space than the ordinary case, while the door arrangement allows the tiers to be much closer together."

FRANCE'S NEW COUNTRY.

A FEW weeks ago a French military expedition, including several hundred Senegalese soldiers, started from the great northern bend of the Mobangi tributary of the Congo on the way north to Lake Tchad. The expedition is under the command of Commandant Destenave. Its purpose is to establish a military government over the countries around Lake Tchad formerly ruled by the Sultan Rabah whom the French a while ago killed in battle. This is the territory of the native empires of Bornu and Bagirmi, which were among the strongest native States in Africa until they were conquered by the invincible guns of Rabah. He carved out a large empire for himself in that part of the Soudan and was the absolute ruler of some millions of people until the French put an end to his rule less than two years ago. The French flag will hereafter float over this richest part of the central Soudan by right of conquest and the treaty arrangements between France and Great Britain, says the New York Sun.

The large river Shari emptying into Lake Tchad on the south, with its sources some hundreds of miles to the southeast, bisects the vast territory of which the French are now taking effective possession. Only the countries in the immediate neighborhood of Lake Tchad gave the French any trouble when they first moved into the country to subdue Rabah; and so the government proposes to differentiate between the peaceful tribes of the south and the fierce warriors of the Lake Tchad Sultanates who fought under Rabah's banner. The country is to be divided into two sections. A civil government is being established by the present expedition over the southern or upper half of the Shari basin. A military government is to be established over the northern or lower part of the river territory which is already held by the French troops.

The people occupying the upper part of the Shari region are among the pagans of Central Africa. Some of the tribes have suffered terribly from the raids of Mohammedan slave stealers, who for years have devastated the country and carried many of the natives into captivity. The situation has been fully explained to the powerful chiefs among them and they say that they gladly welcome the government of France, which they have been told will protect them against the enemies who have so long made them suffer. The French are thoroughly convinced that this part of the country need not be placed under military régime, and so are establishing posts all over the region, manned with sufficient force to carry out the regulations imposed upon the people.

France intends to make both the civil and military governments as nearly self-supporting as possible. It has already arranged to impose a hut tax in the civil district. The tax will be paid in rubber, each hut holder being required to deliver about six pounds of rubber a year. He will take it to his local chief, who will keep a small proportion of the commodity and forward the rest to one or another of the French stations. The rubber and ivory resources of the country are said to be very large.

In the regions of the lower Shari all the laws and regulations imposed upon the people will be dictated by the military régime. The government proposes to collect a tax from all the people, but it will not be onerous. Rabah enriched himself by taxes. He acquired enormous means with which to extend his power by inflicting a most grievous burden of taxation upon the inhabitants of the Sultanates he conquered. It is not expected that the French taxes will amount to more than one-fourth those which the despot Rabah collected.

A large part of the people already understand that the evils inflicted upon them by their conqueror will be removed and that their burden of taxation will be comparatively light. They are therefore submitting most cheerfully to the rule of the French. It is not expected that France will have any particular difficulty in fully establishing its sway over the great and rich country which is quite certain to prove one of the most valuable French possessions in Africa.

THE VINE IN NEW SOUTH WALES.

ALTHOUGH the vine is not indigenous in Australia, there are many places in the island continent where it thrives with a luxuriance unsurpassed by the oldest and richest wine-growing countries of the world. According to Mr. Coghlan, the New South Wales Government Statistician, the vine was planted during the early days of colonization in that state, but it was not until the year 1828 that vine-growing and wine-making may be said to have been fairly established. In that year a leading settler returned from Europe with a large collection of cuttings from the most celebrated vineyards of France, Spain, the valley of the Rhine, and other parts of the Continent of Europe, and planted on his estate at Kirkton, in the Hunter River district, a vineyard which has been the nursery of the principal vineyards of the state. Some years afterward the vine was planted in the Murray River Valley and in other districts, and was found to flourish so luxuriantly that the manufacture of wine received considerable attention. For a time, however, the prospects of this industry seemed very discouraging, and the production was considerably diminished, owing partly to the want of a market, and partly to the fact that the wine makers, many of whom were not vignerons by training, possessed only a limited knowledge of the manufacture of wine, and produced, at first, an article of inferior and unsalable quality. In the principal vineyards in the valley of the Murray and Hunter Rivers, however, neither pains nor money has been spared to introduce skilled labor, and to put up presses, vats, and other manufacturing appliances of the most approved kinds. The result of such intelligent treatment became apparent when prizes were awarded to the wines of New South Wales at the Paris Exhibition of 1878, followed by an unbroken series of successes at the exhibitions of Philadelphia, Sydney, Melbourne, and Amsterdam; and, still more recently, at the Indian and Colonial Exhibition in London. But nowhere was the general excellence of the wines of the colony more fully recognized than at the Bordeaux Exhibition of 1882. There, in the principal center of the wine trade of the world, some of the wines of New South Wales were classed, by the most competent judges, in the category of Grands Vins, and their value fully appreciated and established. Again, at the World's Fair held in 1893 at Chicago, an international jury of experts pronounced the wines of New South Wales to be equal to many of the finest viticultural productions of the noted wine-growing countries of Southern Europe. The opinion was expressed, however, that the practice of labeling Australian wines with European names was to be deprecated, as they possessed many excellent and distinctive characteristics sufficiently peculiar to justify the adoption of a new and descriptive system of classification. During the year ended March 31, 1863, the wine produced in New South Wales measured 144,888 gallons; in 1866, the production reached 168,123 gallons; in 1876 it had increased to 831,749 gallons; in 1886 the production was only 555,470 gallons; in 1896 it reached 885,673 gallons; in 1897 it was 794,256 gallons; in 1898 it was 864,514 gallons; in 1899, 845,-

232 gallons; and in 1900, 739,668 gallons. The highest production was obtained in 1893, the quantity totaling 931,542 gallons—191,847 gallons more than in 1900, although the area under vines for wine-making in the latter year was about the same. Vignerons consider 250 gallons per acre a good yield, but the average yield for New South Wales reached this figure only in one year since the establishment of the industry, viz., in 1876, when the average yield per acre was recorded at 263 gallons. A considerable quantity of the grapes are used for the production of brandy required for fortifying the weaker classes of wines. In 1900 the quantity made was 9,624 gallons. But a considerable portion of the grapes are reserved for table use. In 1900 the quantity thus utilized was 13,697,536 pounds. In previous years the quantity was considerably larger, but it is probable that the favorable season of 1901 will cause a record to be established. Although the finest kinds of grapes, including the muscatel varieties, are cheap and abundant, so far no effort has been made in New South Wales to prepare raisin fruits for foreign consumption, although there is an undoubted possibility of a large export trade in this direction. In Victoria and South Australia settlements have been founded at Mildura and Renmark for the purpose of cultivating, drying, and preserving fruit on a large scale, both for a local and an export trade, similar to the industry as it is conducted in California, where the lands are artificially irrigated, and the efforts of nature are seconded by the discoveries of modern science. Experiments made in drying grapes and currants of Australian culture have met with success in the London markets, and experts have declared the product to be of the highest quality.—Journal of the Society of Arts.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Bicycles in the Netherlands.—Only such American machines as the Cleveland, Rambler, Columbia, etc., are regularly sold. People have no confidence in machines that sell at less than $40 here.

The trouble with all American bicycles is said to be that (1) the factories are too far away, while American sundries are different from European sundries, the consequence being that dealers have to keep in stock a great number of the former, or their customers must wait until the pieces come from the United States, which often takes six weeks or longer; (2) freights are always very high for small sundries, but this will now be improved by the parcel post; (3) most American machines are delivered with single-tube tires, which are not popular here, so that the merchants have to buy double-tube tires at prices ranging from $8 to $12, while the manufacturer makes a reduction of only $5 for the single tubes; (4) American manufacturers prefer sight draft against bill of lading, while European manufacturers give credits of from three to six months, the result being that during last season, more German bicycles were sold here than cheaper American grades.

Of European machines the most sold are English (Humber, Raleigh, Rover, Triumph, Osmond) and Dutch (Hinde, Fongers, and Simplex).

Prices for the next season are:

First-class machines	$60 to $80
Second-class machines	40 to 60
Chainless machines	80 to 100

Chainless machines, as well as bicycles with free wheel, are not popular here.

Bicycles are dutiable at 5 per cent.—Frank D. Hill, Consul at Amsterdam.

Sinking Petroleum Wells in Mexico.—For many years, it has been believed by experts that petroleum existed in Mexico, especially along the Gulf coast, and several parties in years past have drilled in this vicinity (Tampico) in the hope of finding it; but no really determined effort has been made until quite recently, and owners of land are awaiting the results of that effort with much anxiety.

The chief indication of the existence of oil here is the numerous wells of asphalt.

Eastern oil men have passed by this territory, as the surface indications were not good, according to their experience in the eastern fields, and also on the result of the above-mentioned experiments; so it remained for California parties, flushed with success from their oil investments in that State, to detect the possibilities here from the similarity in the surface indications between California and this part of Mexico. They have emphasized their belief by purchasing large tracts of land, building houses, and ordering machinery, preparatory to sinking experimental wells. Other interests have also secured favorable leases.

In addition to the foregoing preparations in the vicinity of Tampico, there is an English company operating south of here in the State of Vera Cruz, the results of which are as yet not known.

It is the general opinion that if oil is found in paying quantities it will be similar to the California product—unprofitable to refine, but good for fuel.

As coal is expensive here and wood is becoming scarcer each year, fuel oil will find a ready market, even if found in large quantities.—Samuel E. Magill, Consul at Tampico.

Electric Tramways in the Canary Islands.—The electric tramway connecting the port of Santa Cruz with the town of La Laguna was opened to the public on March 15, 1901. Besides carrying passengers, the managers have trucks for moving freight, principally fruit, which is the main export from this island. The power house is situated at La Cuesta, a little over half way (about 3 miles) between the two towns and at an elevation of 960 feet, La Laguna being 1,804 feet above the sea level and distant a little over 5.6 miles.

The cars start from the mole at the port and run through the principal street up the main road, which is built on a zigzag plan on account of the grade. It is but a single track, with switches at every kilometer, except in the town of Santa Cruz, where it runs up one and comes down another street. It is an overhead-trolley system, the wires being strung on poles, some of wood and others of iron. In the towns, it is strung over the street from house to house by rivets driven into houses opposite each other and connected with a wire.

The concession for this road was granted at Madrid and includes the whole of the road between Santa Cruz and Orotava. From the present terminus, there will be a regular service of automobiles to the town of Orotava until the tramway is finished. The total length of the line will then be 27 miles. The company is known as Cia. Electrica de Tramvia de Teneriffe. It is a Belgian company and is capitalized for 1,600,000 francs ($308,800). The rails, rolling stock, and machinery were imported from Belgium, although part of the same was originally from Italy, France, and the United States. It is a 3-foot-3-inch grade, and the concession provides that the road must be finished within five years.

There is also a concession for an electric tramway of double-track system between the ports of Luz and Las Palmas, in the island of Grand Canary, which has been granted to a Belgian company. The road will run along the seashore front and will extend from 4 to 5 miles. It will be a great improvement and no doubt a better paying investment than the Santa Cruz-La Laguna road, as Las Palmas is now virtually the principal town of these islands, and is doing about double the business of Teneriffe.—Solomon Berliner, Consul at Teneriffe.

Extinction of Fire Aboard Ships.—Consul Liefeld, of Freiberg, March 13, 1901, sends the following article on extinction of fire on shipboard, taken from The Fire Call, a European journal devoted to the fire service:

Some experiments have been made at Bremen in connection with a new mode of extinguishing fires on board ship, invented by a Berlin chemist of the name of Gronwald. The objects aimed at and said to have been attained by the new system are: First, to give timely notice, by means of a special apparatus, of any fire which may break out in the hold of a ship; and, second, to promptly extinguish the same by pumping carbonic acid gas into the hold.

The official reports of the experiments may be summarized as follows:

Two piles of wood, in all about 4 cubic meters square, were built up in the forehold of a lighter. The large logs were mixed with small blocks of wood and a quantity of wood shavings soaked in petroleum. On the top of the piles of wood was spread about a fourth of a ton of coal, and in the hold was also placed an iron basket filled with coke heated to a perfect glow. The two piles of wood were set alight simultaneously at seven minutes past four in the afternoon. The fire developed quickly with the hatches open, and at twenty-one minutes past four the hatches were closed. Carbonic-acid gas was then pumped into the hold for twenty-one minutes, and ten minutes later the hatches were opened. The fire was found to be completely extinguished. The fire alarm worked perfectly, and the thermometer on deck showed the rise and fall of the temperature in the hold correctly. Later, another experiment was made under exactly the same conditions, except that steam instead of carbonic-acid gas was pumped into the hold after the fire had become well developed. On this occasion, the piles were lighted at ten minutes past nine in the morning, and the hatches were closed fifteen minutes later. Steam of 8 atmospheres, falling rapidly to 1.5 atmospheres, was then discharged into the hold through a hose pipe attached alternately to a couple of steam fire engines. This went on for thirty minutes, and the hatches were then taken off. The fire in the piles of wood was apparently extinguished, but there was yet so much life left in it that one of the piles blazed up again in seven minutes and the other in nine minutes. The fire in the basket of coke was quite out, but a few glimmering sparks remained among the ashes of the wood which had been used for lighting the coke.

Without pronouncing any opinion one way or the other respecting Herr Gronwald's system, suffice it to say that the only new feature in it appears to consist in his employment of carbonic-acid gas. What he claims is that when a fire breaks out in a ship's hold, if his system is followed the fire will be automatically announced on deck; it will be kept under observation from the deck and extinguished by operations carried out on the deck. His system consists in fitting pipes in every compartment of the vessel communicating with the deck, acting as safety valves, through which smoke and heated air may ascend to the deck in case of fire and give the alarm; further, thermometers and alarms may be lowered down these tubes, thus making it possible to watch the progress of a fire in the hold from the deck without either removing the hatches or entering the hold, and, lastly (which is the principal feature of the system), down these pipes is pumped the carbonic-acid gas which will extinguish the fire. The gas can be forced among the cargo at any required pressure, and it will permeate everything, even tightly stowed cotton bales.

Free Homesteads in Canada.—It is officially announced by the Dominion government that a block of 60,000 acres of free-grant land in the Rainy River district of Ontario (in the eastern part of this consular district) has been surveyed and is open to settlement under the "homestead laws" of Canada. However, the general homestead act is somewhat modified as applied to this particular block of lands. Of these lands, any male head of a family or sole female head having a child or children under 18 years of age may locate 160 acres free, and may also purchase an additional 80 acres at $1 per acre. The homesteader must clear and cultivate at least 15 acres, and in no one year less than 2 acres, during three years; must build a habitable house at least 16 by 20 feet in size; and must continuously reside on the land for three years after location. If the 80 acres additional is purchased, at least 15 acres of it must be put under cultivation within three years. Patents may issue at the expiration of three years from date of purchase or sooner if settlement duties have been performed. Minerals and pine lumber are reserved to the government, but the homesteader may use such pine trees as may be needed for building, fencing, and fuel, and may sell such pine trees as may be necessarily removed in the process of clearing, but must pay timber dues on all pine timber sold. All timber remaining on the land when patents issue passes to the patentee. These lands are very fertile and covered by a dense forest, generally of valuable timber. The Ontario and Rainy River Railroad, now nearing completion, runs through this block of land and brings it within easy reach of markets. This railroad is a link of the Canadian Northern system, which, within the next six or eight months, will have a continuous line from Port Arthur, on Lake Superior, to Winnipeg and thence 300 miles northwest.—W. H. H. Graham, Consul at Winnipeg.

American Mill Machinery for Turkey.—Capital has been enlisted for the introduction into the vilayet of Mamouret-ul-Aziz of flouring mills and of mills for spinning and weaving the simpler cotton fabrics. It is desired to secure American machinery for this purpose. At present, wheat is ground by primitive methods. The cleaning of the cotton is likewise effected in a very primitive manner.

While the vilayet produces an abundant supply of cotton (about 5,000 short tons per annum), the woven tissues are imported almost exclusively from Manchester.

There is an abundance of water power for milling purposes.

I would request American manufacturers of cotton gins, machinery for cotton mills (including full installation), and machinery for flouring mills (including installation) to send to this consulate their descriptive price lists.

In these catalogues, attention should be directed more particularly to the simpler mechanical devices, which can be conducted by low-grade workmen and can be most easily repaired in a country destitute of skilled mechanics and modern appliances.

Lowest net prices should be indicated, including satisfactory packing for a long journey, involving a fortnight's constant jolting. It would be advisable in subsequent communication to give net prices for the simpler types above mentioned f. o. b. Samsoun—i. e., via the English direct lines, transshipping at Liverpool.—Thomas H. Norton, Consul at Harput.

Steamship Line Between Odessa and the Persian Gulf.—Consul-General Bowen, of Teheran, under date of February 25, 1901, reports the establishment of a Russian line of steamers between Odessa and the Persian Gulf. The trade with southern Persia, says the Consul-General, has hitherto been so conspicuously in the hands of the English that their influence was considered to be practically unrivaled. It seems, however, that Russia has decided to enter into competition with Great Britain in this sphere, although at first she will labor under a serious disadvantage, as Russian goods are generally inferior to those of Great Britain. In order to overcome this drawback, Russia, it is said, will subsidize the new line and grant bounty concessions to all goods carried. It is intended, adds Mr. Bowen, that the new line of steamers shall supply the Persian market with sugar, cotton goods, and petroleum; but, as Persia has neither produce nor goods that are needed in Russia, the return cargoes will be practically nil, and it is doubtful whether the line will ever be self-supporting.

New Railways in Southern Russia.—Consul Hughes, of Coburg, reports that three new railway lines have been planned or are already under construction on the eastern and northeastern shores of the Black Sea. The first line is to join Novorossisk to the Caucasus Railway and will start from the Vladikavkas line, cross the mountain chain by the Malkope route, and proceed along the coast down the Sukhum Kale. This line is to be only 28 miles in length, but its continuation to Novo-Senake, on the Trans-Caucasian Railway, will shorten the route from Rostof, the port on the Lower Don, not far from the sea of Azof, to Tiflis, the capital of Trans-Caucasia, by 450 miles. The new standard-gage railway, however, would open up a number of government coal mines. The second line is to start from Tiflis and pass through the wine-growing districts of Kakhetie. The third project concerns the mines of Sadonsk and the metallurgical districts of Alaguir, in the northern Caucasus, which are reported to be very rich in argentiferous lead and zinc ores. The railway is to start from Vladikavkas and will traverse the country of the Terek Cossacks.

Naval and Military Exhibition in Great Britain.—The Department has received a prospectus of the naval and military exhibition to be opened at the Crystal Palace, Sydenham, May 2, 1901, comprising exhibits in connection with the transport and equipment of the army and navy, progress in naval architecture in its application to purposes of national defense and commerce.

Brazilian Rubber Concession.—Consul Kenneday writes from Para that he is informed that the State of Amazonas, desiring to develop the rubber trade in that section, offers a reduction of 10 or 15 per cent of the export duties on rubber, and permission to cut and pack in its own bonded stores, to a syndicate that will take charge of the trade; the price to be paid for this concession being $2,000,000.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1017. April 22.—New Russian Tariff—How to Create American Trade in France.

No. 1018. April 23.—Sugar-Beet Industry in Europe—Paper Currency of Siam—*Improvement in Brazilian Cable Service.

No. 1019. April 24.—Improvements on the Nile.

No. 1020. April 25.—Austria's Coal Production—The Vancouver Coal Mines—*Improved German Life-Saving Apparatus—British Columbia Salmon Industry—*Trade Openings in Brazil—Rosario Port Works.

No. 1021. April 26.—Wood Paving in London—Finances of Haiti—Coal, Iron and Steel Production of France—*Hints to Exporters to the Argentine Republic.

No. 1022. April 27.—Conditions in the Yukon—Mannheim as a Center for American Manufactures—Woolen Yarns in Germany—Mileage of European Railways—Education of German Children in Foreign Countries—Lead Pencils in Germany—German Prize for Cooling Beer.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Preserving Shoe Blacking.—The various blackings for foot-gear usually present the disadvantage of rendering the leather very brittle, while, it is true, they make it shine in a most remarkable manner. Following is a recipe which has given good results for the preservation of black leather. Dissolve 28 grammes of Marseilles soap in 85 grammes of water, adding thereto about 200 grammes of alcohol. Macerate in a medium warm place, shaking frequently; finally filter through cotton. Proceed in the same manner for a solution composed of mastic 14 grammes, sandarac 28 grammes and Venetian turpentine 56 grammes, all dissolved in 250 grammes of alcohol. Next dissolve in 225 grammes of alcohol 42 grammes of aniline black and 105 grammes of shellac. Mix the three solutions, add 56 grammes of glycerine, and fill in a wide-necked bottle, from which it is drawn up, to be spread upon the leather, by means of a little sponge fixed at the end of an iron wire.—La Nature.

Burnt Almonds.—The Pharmaceutische Zeitung gives the following directions for their production: Carefully separate from dust by the aid of a sieve

Choice sweet almonds	1000.0

And warm in a pot over a moderate fire, with stirring, until they have all become uniformly hot. Meanwhile boil almost to the consistency of candy

Sugar	1000.0
Starch sirup	100.0
Water	150.0

And add:

Cinnamon	20.0
Red chalk	25.0
Cloves	7.5
Vanilla sugar	25.0

The hot almonds are now put in the boiling hot sugar mass, which is allowed to stand for a moment longer on the fire, stirring constantly until the almonds crack. Then the substance is carefully spread on a feebly oiled copper sheet by means of a copper spatula. Let cool and distribute the mass.

Leaded Sheet Iron.—For many purposes leaded sheet iron is employed in place of sheet zinc, which is, although like sheet zinc, not subject to rusting, considerably more resistent to dents and cheaper in price. The treatment of leaded iron, however, is not so very simple, or at least it must be treated very carefully, so as not to forfeit the non-rusting properties. Special care has to be taken that the lead surface is not injured anywhere by working on it; hence above all that no filing is done on it. The cut edges must be folded in such a manner as to be perfectly isolated from the interior and the exterior of the article in question. The soldering likewise requires special attention, otherwise the joints will not be durable. The places to be soldered are best treated with glass paper or emery cloth, whereby the oxide layer of the lead coating is removed. Next tin the lead surface by means of the soldering iron or in the flame, and a subsequent soldering with the iron in the regular manner will prove just as durable as the zinc soldering. If all the cut edges cannot be hidden in folds it is well not to turn them to the inside but to the outside, where they can be more easily protected from rust by varnish. Any spot bared of lead, on the edges or where filing has been done, will naturally be attacked by rust when air or water containing air has access to the interior, and the rusting through of the comparatively thin sheet will soon follow. On the other hand, unlimited durability and immunity from rusting through may be looked for in hollow bodies of leaded sheet iron which have been carefully treated according to the above suggestions.— Eisenhändler.

New Process to Color Plaster of Paris.—If burnt gypsum is stirred with water containing formaldehyde and some alkali, adding thereto the necessary quantity of water for hardening the plaster of Paris, which water contains a reducible metallic salt in solution, a plaster of Paris mass of perfectly uniform coloration is obtained. The process takes place in a very short time and the setting of the gypsum pulp is in no way affected. According to the choice of the salts and the concentration of the metallic salt solutions, various shades of black, red, brown, violet, pearl-gray, bronze, etc., may be produced.

Besides, the color effect may be increased by the admixture of certain pigments. For the production of a gray-colored gypsum, for example, proceed in the following manner: Stir 50 grammes of gypsum with one-fourth its weight of water containing a few drops of formaldehyde and some soda-lye and add 10 drops of a 1-10 normal silver solution, which has previously been mixed with the quantity of water necessary for hardening the gypsum. The substance, after stirring, immediately acquires a uniform pearl-gray coloring.

In order to obtain shades of red or copper or black or bronze, salts of gold, of copper or of silver, of bismuth or of lead, may be employed singly or mixed. The colorings, of course, admit of a large number of modifications. In lieu of formaldehyde other reducing agents may be employed, as solutions of sulphurous acid or hydrogen peroxide with a little alkali. The latter, for instance, acts upon gold according to the following formula:

$$\underset{\text{gold chloride}}{2\,AuCl_3} + \underset{\text{hydrogen peroxide}}{3\,H_2O_2} + \underset{\text{caustic alkali}}{6\,KOH} =$$

$$\underset{\text{gold}}{2\,Au} + \underset{\text{oxygen}}{6\,O} + \underset{\text{potassium chloride}}{6\,KCl} + \underset{\text{water}}{6\,H_2O}$$

Metals in the elementary state may likewise be used; iron, for instance, stirred with some copper solution, and gypsum furnishes a brown mass excelling in special hardness. This process for coloring gypsum differs from those formerly practised in that the coloration is caused by metals in the nascent state, and an extraordinarily fine division is effected. The advantage of the method consists in that colorings are attained with slight quantities of a salt. Besides, the fine contours of the figures are in no wise affected by this style of coloring, a further advantage consisting in the coloration throughout the mass whereby great durability of the hue against outside actions is obtained. Thus it is, for instance, impossible for the dyestuff to peel off or rub off.—Deutsche Töpfer- und Ziegler Zeitung.

VALUABLE BOOKS

JUST PUBLISHED.

The Progress of Invention in the Nineteenth Century.

By EDWARD W. BYRN, A.M.

Large Octavo. 480 Pages. 300 Illustrations. Price $3 by Mail, Postpaid. Half Red Morocco, Gilt Top, $4.

The most important book ever published on invention and discovery. It is as readable as a novel, being written in popular style.

The book gives a most comprehensive and coherent account of the progress which distinguishes this as the "golden age of invention," resulting in industrial and commercial development which is without precedent. A chronological calendar of the leading inventions is one of the most important features of the book, enabling the reader to refer at a glance to important inventions and discoveries of any particular year. The book is printed with large type, on fine paper, and is elaborately illustrated with 300 engravings and is attractively bound.

EXPERIMENTAL SCIENCE.

By GEORGE M. HOPKINS.

This is a book full of interest and value for teachers, students and others who desire to impart or obtain a practical knowledge of Physics.

This splendid work gives young and old something worthy of thought. It has influenced thousands of men in the choice of a career. It will give anyone, young or old, information that will enable him to comprehend the great improvements of the day. It furnishes suggestions for hours of instructive recreation.

20th edition. Revised and enlarged. 914 pages. 820 illustrations. Elegantly bound in cloth. Price, by mail, postpaid, **$4.00**; Half Morocco, **$5.00.**

THE SCIENTIFIC AMERICAN

Cyclopedia of Receipts, Notes and Queries

Edited by ALBERT A. HOPKINS.

This splendid work contains a careful compilation of the most useful Receipts and Replies given in the Notes and Queries of correspondents as published in the SCIENTIFIC AMERICAN during the past fifty years; together with many valuable and important additions.

Over twelve thousand selected receipts are here collected; nearly every branch of the useful arts being represented. It is by far the most comprehensive volume of the kind ever placed before the public.

12,500 receipts. 734 pages. Price **$5** in cloth; **$6** in sheep; **$6.50** in half morocco; postpaid.

A COMPLETE ELECTRICAL LIBRARY.

By Prof. T. O'CONOR SLOANE.

An inexpensive library of the best books on Electricity. Put up in a neat folding box. For the student, the amateur, the workshop, the electrical engineer, schools and colleges. Comprising five books as follows:

Arithmetic of Electricity, 138 pages	$1.00
Electric Toy Making, 140 pages	1.00
How to Become a Successful Electrician, 139 pages	1.00
Standard Electrical Dictionary, 682 pages	3.00
Electricity Simplified, 158 pages	1.00

Five volumes, 1,361 pages, and over 450 illustrations.

A valuable and indispensable addition to every library.

Our Great Special Offer.—We will send prepaid the above five volumes, handsomely bound in blue cloth, with silver lettering, and inclosed in a neat folding box, at the **Special Reduced Price of $5.00** for the complete set. The regular price of the five volumes is $7.00.

MAGIC

Stage Illusions and Scientific Diversions, including Trick Photography.

By A. A. HOPKINS.

The work appeals to old and young alike, and it is one of the most attractive holiday books of the year. The illusions are illustrated by the highest class of engravings, and the exposés of the tricks are, in many cases, furnished by the prestidigitators themselves. Conjuring, large stage illusions, fire-eating, sword-swallowing, ventriloquism, mental magic, ancient magic, automata, curious toys, stage effects, photographic tricks, and the projection of moving photographs are all well described and illustrated, making a handsome volume. It is tastefully printed and bound. Acknowledged by the profession to be the **Standard Work on Magic.** 508 pages. 420 illustrations. Price **$2.50.**

AN AMERICAN BOOK ON

Horseless Vehicles, Automobiles and Motor Cycles.

OPERATED BY

Steam, Hydro-Carbon, Electric and Pneumatic Motors.

By GARDNER D. HISCOX, M.E.

This work is written on a broad basis, and comprises in its scope a full illustrated description with details of the progress and manufacturing advance of one of the most important innovations of the times, contributing to the pleasure and business convenience of mankind.

The make-up and management of Automobile Vehicles of all kinds is liberally treated, and in a way that will be appreciated by those who are reaching out for a better knowledge of the new era in locomotion.

The book is up to date and very fully illustrated with various types of Horseless Carriages, Automobiles and Motor Cycles, with details of the same. Large 8vo. About 450 pages. Very fully illustrated. Price **$3.00,** postpaid.

GAS ENGINE CONSTRUCTION.

By HENRY V. A. PARSELL, Jr., Mem. A. I. Elec. Eng., and ARTHUR J. WEED, M.E.

PROFUSELY ILLUSTRATED.

This book treats of the subject more from the standpoint of practice than that of theory. The principles of operation of Gas Engines are clearly and simply described, and then the actual construction of a half-horse power engine is taken up.

First come directions for making the patterns; this is followed by all the details of the mechanical operations of finishing up and fitting the castings. It is profusely illustrated with beautiful engravings of the actual work in progress, showing the modes of chucking, turning, boring and finishing the parts in the lathe, and also plainly showing the lining up and erection of the engine.

Dimensioned working drawings give clearly the sizes and forms of the various details.

The entire engine, with the exception of the fly-wheels, is designed to be made on a simple eight-inch lathe, with slide rests.

The book closes with a chapter on American practice in Gas Engine design and gives simple rules so that anyone can figure out the dimensions of similar engines of other powers.

Every illustration in this book is new and original, having been made expressly for this work.

Large 8vo. About 300 pages. Price **$2.50,** postpaid.

MECHANICAL MOVEMENTS,

Powers, Devices, and Appliances.

By GARDNER D. HISCOX, M.E.

A Dictionary of Mechanical Movements, Powers, Devices and Appliances, embracing an illustrated description of the greatest variety of mechanical movements and devices in any language. A new work on illustrated mechanics, mechanical movements, devices and appliances, covering nearly the whole range of the practical and inventive field, for the use of Machinists, Mechanics, Inventors, Engineers, Draughtsmen, Students and all others interested in any way in the devising and operation of mechanical works of any kind.

Large 8vo. 400 pages. 1,540 illustrations. Price **$3.**

Liquid Air and the Liquefaction of Gases.

By Prof. T. O'CONOR SLOANE.

This book contains the full theory of the subject. It gives the entire history of the Liquefaction of Gases from the earliest time to the present, and contains an illustrated description of all the experiments that have excited the wonder of audiences all over the country. It is a logical explanation and application of the principles of liquefaction, a history of the theory, discovery and manufacture of liquid air. A book that renders simple one of the most perplexing chemical problems of the century. Startling developments illustrated by actual experiments. It is not only a work of scientific interest and authority, but is intended for the general reader, being written in a popular style—easily understood by everyone.

356 pages. With many illustrations. Price **$2.50.**

☞ *Full descriptive circulars of above books will be mailed free upon application.*

MUNN & CO., Publishers, 361 Broadway, N. Y.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents and canvassers.

MUNN & CO., Publishers, 361 Broadway, New York.

TABLE OF CONTENTS.

PAGE

I. AERONAUTICS.—Heinrich Suter's Airship.—1 illustration.... 21200

II. AGRICULTURE.—Sugar Plantation in Hawaii.... 21204
The Vine in New South Wales.... 21213

III. AUTOMOBILE.—Automobile Competition in 1900.—3 illustrations.... 21202
Prospects for Economical Automobiling.—By M. C. KRARUP.... 21201

IV. BIOGRAPHY.—Charles H. Haswell, M.E.—1 illustration.... 21199

V. CHEMISTRY.—Experiments with Cæsium Compounds.... 21211

VI. COMMERCE.—Trade Suggestions from United States Consuls.... 21213

VII. ELECTRICITY.—Contemporary Electrical Science.... 21200
Electric Furnaces.... 21200
Reporting Steamships.... 21200

VIII. GEOGRAPHY.—The Great Salt Lake.—By Prof. RALPH S. TARR, of Cornell University.... 21204

IX. GEOLOGY.—Table Glaciers of the Antarctic Regions.... 21204

X. MECHANICAL ENGINEERING.—Deadening the Noise of Machinery.... 21203
Petroleum Turbine.... 21203

XI. MEDICINE AND SURGERY.—New Process of Pelvimetry and Long Distance Radiography.... 21210

XII. MISCELLANEOUS.—Consumption of Coal Dust in Germany.... 21203
Moving Large Palms in California.—By CHARLES FREDERICK HOLDER.... 21211
Salt Mining in China.—1 illustration.... 21202
Trade Notes and Receipts.... 21214

XIII. NATURAL HISTORY.—A Report Concerning the Cattle of Porto Rico.—By RICE P. STEDDOM.... 21206
Destructive Insects and Insects as Ethological Factors in Disease.—By Prof. HENRY SKINNER, M.D.... 21207
An Indictment of the Rat.... 21209
Living Milestones.—By R. LYDEKKER.... 21205
The Herbarium Cases at the Field Columbian Museum, Chicago.—1 illustration.... 21212

XIV. PSYCHOLOGY.—Studies in Visual Sensation.—Abstracts of the Croonian Lecture delivered at the Royal Society on March 21.—By Principal C. LLOYD MORGAN, F.R.S.... 21210

XV. RAILWAYS.—A Trans-Australian Railway.... 21199

XVI. TRAVEL AND EXPLORATION.—France's New Country.... 21212

Automobiles

The SCIENTIFIC AMERICAN for May 13, 1899, is devoted mainly to illustrations and detailed descriptions of various types of horseless vehicles. This issue also contains an article on the mechanics of the bicycle and detailed drawings of an automobile tricycle. Price 10 cents.

The following copies of the SCIENTIFIC AMERICAN SUPPLEMENT give many details of Automobiles of different types, with many illustrations of the vehicles, motors, boilers, etc. The series make a very valuable treatise on the subject. The numbers are: 732, 979, 993, 1053, 1054, 1055, 1056, 1057, 1058, 1059, 1075, 1078, 1080, 1082, 1083, 1099, 1100, 1113, 1122, 1178, 1195, 1199, 1206, 1210. SUPPLEMENT No. 1229 contains a highly interesting article giving full data as to operating costs of horse and electric delivery wagons in New York city. Price 10 cents each, by mail. For sale by all newsdealers, or address

MUNN & CO., Publishers,

361 Broadway, - - - New York City.

BUILDING EDITION

OF THE

SCIENTIFIC AMERICAN.

Those who contemplate building should not fail to subscribe.

ONLY $2.50 A YEAR.

Semi-annual bound volumes $2.00 each, yearly bound volumes $3.50 each, prepaid by mail.

Each number contains elevations and plans of a variety of country houses; also a handsome

COLORED PLATE.

SINGLE COPIES - - - - 25 CENTS EACH.

MUNN & CO., 361 Broadway, New York.

PATENTS!

MUNN & CO., in connection with the publication of the SCIENTIFIC AMERICAN, continue to examine improvements, and to act as Solicitors of Patents for Inventors.

In this line of business they have had over *fifty years' experience*, and now have *unequaled facilities* for the preparation of Patent Drawings, Specifications, and the prosecution of Applications for Patents in the United States, Canada, and Foreign Countries. Messrs. MUNN & CO. also attend to the preparation of Caveats, Copyrights for Books, Trade Marks, Reissues, Assignments, and Reports on Infringements of Patents. All business intrusted to them is done with special care and promptness, on very reasonable terms.

A pamphlet sent free of charge on application containing full information about Patents and how to procure them; directions concerning Trade Marks, Copyrights, Designs, Patents, Appeals, Reissues, Infringements, Assignments, Rejected Cases, Hints on the Sale of Patents, etc.

We also send, *free of charge*, a Synopsis of Foreign Patent Laws showing the cost and method of securing patents in all the principal countries of the world.

MUNN & CO., Solicitors of Patents,

361 Broadway, New York

BRANCH OFFICES.—No. 625 F Street, Washington, D. C.

XUM